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INJURY EPIDEMIOLOGY REPORT 2008
DECEMBER 2009

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14. ABSTRACT

Injuries are a leading cause of death, disability, and medical encounters among Active Duty U.S. Army personnel. Medical surveillance data provide a useful tool for defining the magnitude of the Army injury problem, injury rates and trends, and causes of injuries. This report summarizes injuries among Active Duty, nondeployed U.S. Army Soldiers in 2008 using available medical surveillance data. In 2008, over 900,000 medical encounters were due to injury. Among Army Soldiers, the 2008 injury visit rate was 2,341 injury visits/1,000 Soldiers, or 2.3 visits/Soldier. Injury visit rates increased 28.6 percent from 2005 to 2008, while trainee rates from 2003 to 2008 declined by 37.8 percent. Injuries accounted for 16.9 percent of all hospitalizations and 28.1 percent of all outpatient visits. Leading causes of hospitalizations were falls or near-falls (18.4 percent), land transport accidents (18.4 percent), and athletics/sports (9.3 percent). Leading types of acute injuries were sprains/strains, contusions/superficial wounds, and fractures. Leading chronic injury conditions were inflammation and pain associated with overuse and joint derangements. These results provide important indicators of potential injury prevention targets and research priorities. Summaries of Injury Prevention Program analyses, field investigations, and evaluations completed in 2008 are also presented.

15. SUBJECT TERMS
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EXECUTIVE SUMMARY
USAPHC (PROV) REPORT NO. 12-HF-0APLa-09
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1. PURPOSE. The main purposes of this report are as follows:

a. To present and summarize available medical surveillance data for use in injury prevention program and policy planning, including—

(1) Defining the relative impact of injury compared to other medical conditions among U.S. Army Active Duty personnel in 2008.

(2) Providing Army injury rates and trends from 2000–2008.

(3) Identifying leading causes (for injury hospitalizations) and injury types (for hospitalizations and outpatient visits) for 2008.

b. To provide a summary of key results from nondeployment-related analyses, field investigations, and evaluations completed in 2008 by the Injury Prevention Program at the U.S. Army Public Health Command (Provisional) (USAPHC (Prov)), formerly known as the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM).

2. CONCLUSIONS.

a. <u>Army Injury Surveillance Summary 2008</u>. This section summarizes available medical surveillance data affecting Active Duty, nondeployed U.S. Army Soldiers. Key findings indicated–

(1) For every 1 injury-related death, there were 18 hospitalizations and 1,655 outpatient visits in 2008.

(2) Injury was the leading cause of medical encounters (909,989 medical encounters in 2008), affecting over 250,000 Soldiers.

(3) Among Army Soldiers, injury visit rates increased 28.6 percent from 2005 to 2008, while rates among Army trainees from 2003 to 2008 declined by 37.8 percent.

(4) Injury was one of the leading causes of hospitalization among Army Soldiers (5,871 hospitalizations in 2008), exceeded only by mental disorders. Injury and injury-related musculoskeletal conditions resulted in more outpatient visits (546,032 outpatient visits in 2008) than any other medical condition.

(5) The most frequently reported causes of accidental injuries that required hospitalization were falls or near-falls (e.g. slips, trips) (18.4 percent), land transport accidents (18.4 percent), and athletics/sports (9.3 percent).

(6) The most common, specific-injury types leading to hospital admission were fractures (37.3 percent), internal injuries (12.6 percent) and sprains/strains (9.3 percent). Injury hospitalizations were most likely to involve the upper (18.0 percent) or lower (26.9 percent) extremities.

(7) Injury-related outpatient visits were most commonly the result of sprains and/or strains (51.0 percent), contusions/superficial wounds (16.7 percent), and fractures (9.5 percent), particularly sprains and strains to the lower leg, ankle, shoulder and upper arm.

(8) The most common types of injury-related musculoskeletal conditions leading to hospital admission were joint derangement (45.3 percent), inflammation and pain associated with overuse (28.1 percent), and sprains/strains/ruptures (13.3 percent). The greatest proportion of hospitalizations involved the spine and back (41.6 percent), followed by lower extremities (34.6 percent).

(9) Most injury-related, musculoskeletal conditions treated on an outpatient basis were due to inflammation and pain associated with overuse (85.5 percent), followed by joint derangement (7.7 percent) and joint derangement with neurological involvement (3.1 percent). Over 75 percent of outpatient visits for injury-related musculoskeletal conditions affected two body regions—the spine/back (33.1 percent) and lower extremities (45.1 percent).

b. <u>Army Injury Epidemiology Project Summaries 2008: Analyses, Investigations, and Evaluations</u>. Conclusions from the USAPHC (Prov) Injury Prevention Program nondeployment related injury investigations completed in 2008 were as follows:

(1) *Setting Priorities in Preventive Medicine*. A prioritized list of the U.S. Army's top ten injury issues (currently used to direct USAPHC (Prov) injury prevention efforts)

was generated utilizing a systematic, evidence-based process. Using data, predetermined criteria, and an objective rating process, the top Army injury prevention priorities were determined to be physical training, privately owned motor vehicle accidents, athletic/sports, excessive heat, military motor vehicle accidents, falls/jumps, marching/drilling, lifting/pushing/pulling, military air transport accidents, and excessive cold.

(2) *Establishing Evidence-Based Injury Prevention Priorities: An Example Process.* Three ranking procedures (mean scores, harmonic mean scores, and weighted, normalized mean scores) resulted in the same top two injury issues: physical training injuries and motor vehicle accidents. The following causes of injury also appeared in the top ten, regardless of ranking procedure (listed in rank order by mean scores): physical training, privately owned vehicle accidents, athletics/sports, excessive heat, military motor vehicle accidents, falls/jumps, marching/drilling, lifting/pushing/pulling, military air transport accidents, and excessive cold.

(3) *The Five Essential Elements of the Public Health Process/Practice.* The five elements of the public health process, necessary to make continued progress toward prevention of disease and injury are: (1) surveillance, (2) research and field investigation, (3) intervention trials, (4) program and policy implementation, and (5) evaluation of strategies, programs, and policies.

(4) *Putting the Public Health Process into Practice: Examples of Public Health Program and Policy Evaluations.* Effective program evaluations resulted in modifications to physical training and reintroduction of parachute ankle braces in Army airborne training.

(5) *Approaches to Injury Surveillance at the Local Level.* Surveillance systems at the Armed Forces Health Surveillance Center and the U.S. Army Public Health Command (Provisional) can be utilized by preventive medicine and public health personnel to identify injury occurrences and to be alerted of emerging injury problems.

(6) *Department of Defense Injury Burden: A Summary of Medical Surveillance Data.* Medical surveillance data provide a means of tracking injury rates, establishing leading causes, and providing information needed to prioritize Department of Defense injury prevention efforts.

(7) *Injury-Related Musculoskeletal Conditions: An Under-Recognized Injury Problem among Military Personnel.* When injury-related musculoskeletal conditions are combined with acute traumatic injuries, there are almost 1.6 million injury-related medical encounters in the military Services each year, an almost 50 percent increase in

the number of annual clinical encounters for injuries. The additional injury encounters are largely for conditions such as stress fractures and Achilles tendonitis; conditions that are well recognized as injuries in the sports medicine community. The injury-related musculoskeletal condition matrix is an epidemiologic tool that provides a standardized format to categorize these injuries, make comparisons over time, identify leading injury types and/or body regions upon which prevention efforts can focus.

(8) *Oral-Maxillofacial Injuries among Active Duty U.S. Military Personnel, 1996–2005*. The oral-maxillofacial fracture rates for men were consistently 1.5 to 2 times higher than those for women. Unlike fractures, wound rates for men and women were similar over time. Active Duty personnel under age 25 had the highest rates of both oral-maxillofacial fractures and wounds. Fighting (13.5 percent) and land-transport accidents (8.4 percent) were the leading causes of oral-maxillofacial injury hospitalizations in 2005, followed by war-related incidents (8 percent), gun/explosives training and handling (8 percent), and falls (5.1 percent).

(9) *The Epidemiology of Falls, Slips, and Trips in the U.S. Army.* Analysis of medical surveillance and administrative data has demonstrated that slips, trips, and falls account for 16-18 percent of Army injury hospitalizations annually. Such injuries, whether suffered at home or overseas, result in unnecessary costs including medical expenses, lost work time, and manpower reductions.

(10) *The Association of Health Risk Behaviors, Risk-Taking, and Injuries during Army Basic Combat Training*. Among males, risk-taking and cigarette use were associated with training-related injury while controlling for known risk factors. Among females, injury risk was associated with individual health risk behaviors related to cigarette use and diet/lifestyle choices. These data suggest that training-related injury risk, particularly among male Soldiers, is influenced by risk taking-tendency, a potentially modifiable risk factor.

(11) *Risk Factors for Injury and Cigarette Smoking and Temporal Trends in Demographic and Lifestyle Characteristics among U.S. Army Ordnance School Students.* Temporal trends among U.S. Army Ordnance School Service Members from 2000–2006 included an increase in older Service Members, Caucasians, and fewer men smoking more than 20 cigarettes per day. For both men and women, self-reported injury was associated with older age and a current self-reported illness. The likelihood of smoking on 20 or more days prior to Basic Combat Training was associated with older age, Caucasian race, and smokeless tobacco use.

(12) *Effects of Age and Smoking Prior to Basic Combat Training (BCT) on Initial Fitness Levels on Entry to BCT*. Physical fitness appears to be negatively influenced by

smoking and age in this population of Army basic trainees, but those who smoked prior to Basic Combat Training did not show greater age-related decrements in fitness than nonsmokers.

(13) *Prevention of Stress Fractures: Tested Interventions and Methodological Issues*. While several interventions appear promising, most studies have methodological problems and most promising interventions have only been tested in a single study, so clear recommendations to prevent stress fractures cannot be made at this time.

(14) *Associations between Physical Fitness and Stress Fracture Incidence.* Low aerobic fitness is associated with a higher incidence of stress fractures. It is not clear whether muscular strength or muscular endurance is associated with stress fractures. Measures of flexibility do not appear to be associated with stress fractures.

(15) *Influence of Iron Supplementation on Injury Risk in Basic Combat Training*. This study lacked the statistical power to determine conclusively that iron supplementation reduces injuries in Army Basic Combat Training.

(16) *Injury Reduction Effectiveness of Prescribing Running Shoes based on Foot Shape in Basic Combat Training*. This prospective study demonstrated that prescribing shoes on the basis of the shape of the plantar foot surface had little influence on injury risk in Army Basic Combat Training even after control of known injury risk factors.

(17) *Injury Reduction Effectiveness of Prescribing Running Shoes based on Foot Shape in Air Force Basic Military Training.* This prospective study demonstrated that prescribing shoes on the basis of the shape of the plantar foot surface had little influence on injury risk in Air Force Basic Military Training even after control of other injury risk factors.

(18) *Risk Factors for Parachute Injuries and Airborne Student Observations on the Parachute Ankle Brace.* Among male students of all Services attending the U.S. Army Airborne School, independent risk factors for injuries in the past year included Airborne recycling, less physical activity, older age, and higher body mass index. Risk factors independently associated with jump-week injuries included older age, Airborne recycling, higher body weight, not wearing the parachute ankle braces (PAB), aircraft exit problems, and injury in the past year. Students who had worn the PAB had more favorable attitudes toward the PAB than those who had not worn it. Most negative PAB comments were related to the heel strap. An improvement has been proposed and is in production. Students complained that the PAB rubbed on the legs, shin, ankle, and calf; this might be alleviated by improvements in the heel strap and/or better guidance on

appropriate tightness for the ankle straps. Students complained of difficulty in keeping the feet and knees together when wearing the PAB. This may just be a matter of perception, and/or some adaptation and accommodation may be required in this area. The bottom line is that the PAB prevents ankle injuries during airborne training (with the T-10 parachute).

(19) *A Survey of Parachute Ankle Braces Breakages.* The major breakage location on the parachute ankle braces (PAB) was the heel strap. On the heel strap, the Velcro®, the center of the strap, and the rivet on the Velcro end were the specific areas subject to the greatest number of breakage events. A proposed modification has been developed by DJO Incorporated in consultation with the U.S. Army Airborne School to more effectively hold the brace on the boot and reduce heel strap breakages. This modification adds a strap over the dorsum of the foot. The ankle strap at the Velcro attachment was also found to have a high level of breakage, and strengthening the attachment of the Velcro hooks to the strap may decrease the breakage incidence in this area. The modification of the plastic shell in the third generation PAB may result in less shell breakage, as well. (Velcro® is a registered trademark of Velcro Industries B.V.)

3. RECOMMENDATIONS.

a. Recommendations Resulting from Army Injury Surveillance 2008.

(1) Given the magnitude of the injury problem in the Army as demonstrated by these data, resources should be directed toward injury prevention and research activities.

(2) To most effectively and efficiently address Army injuries, a data-driven prioritization process is recommended to focus resources on the most preventable of the leading Army injury problems.

(a) The process should include the analysis of nonfatal medical surveillance data, as presented in this report, given that the bulk of the Army injury burden is nonfatal injuries.

(b) When formulating prevention priorities, factors that should be considered include the frequency, incidence, and severity of injuries; resulting costs; size of the population at risk; preventability of the problem; feasibility of establishing prevention programs or policies; and the ability to evaluate the effect of implemented programs and policies.

(c) When formulating research priorities, factors similar to those used to prioritize prevention should be considered. These should include not only the frequency, incidence, and severity of injuries; resulting costs; and size of the population at risk; but also, existence of gaps in knowledge of prevention; military uniqueness; potential value of the research; and feasibility of the research.

(3) Results of this analysis should be used to inform injury prevention and research priorities.

(a) Falls/near-falls, transport accidents, and sport-related injuries should be a focus for prevention and research activities for the Army.

(b) Fractures, sprains, and strains, and overuse injuries of the back and lower extremities represent the types of injury to focus prevention and research activities for the Army.

(4) Data in this report should also be combined with future injury surveillance analyses to identify trends in injury rates and causes over time.

b. <u>Recommendations Resulting from Army Injury Epidemiology Project</u>.

(1) Prevention Planning Recommendations

(a) The USAPHC (Prov) criteria for prioritizing programs and policies should be used to systematically assess and prioritize injury and disease prevention initiatives in the U.S. military. The process of establishing evidenced-based prevention priorities reduces subjectivity and conflicts of interest in setting priorities and could be adapted for use in safety and public health prevention planning in the Army and other populations. Prevention resources can be allocated more efficiently and effectively using objective criteria to identify the biggest, most preventable problems.

(b) Public health and preventive medicine programs should engage in each of the five steps of the public health process, in order to effectively prevent or mitigate injuries in the U.S. military. Implemented policies, programs, and interventions should be evaluated for effectiveness as part of the public health process. The USAPHC (Prov) Injury Prevention Program is a potential resource for installation preventive medicine personnel to assist with executing various aspects of the public health process.

(2) Injury Surveillance Recommendations

(a) Available medical surveillance data should be utilized to track injury rates, establish leading causes, and provide information needed to prioritize Army injury prevention efforts. Preventive medicine and public health personnel at local military treatment facilities should routinely access surveillance systems and other resources to identify emerging injury issues and prioritize their efforts in addressing current injury issues.

(b) When assessing the magnitude of the injury problem in the military Services, injury-related musculoskeletal conditions, such as stress fractures, Achilles tendonitis, and plantar fasciitis, should be included.

(c) The military would benefit from a system of surveillance that incorporates not only medical care data, but also dental care data.

(3) Injury Research and Field Investigations Recommendations

(a) Because of the magnitude and severity of the problem with falls in the U.S. Army, additional research on risk factors, causes, and interventions to prevent falls among working-age populations is needed.

(b) Intervening on potentially modifiable risk factors for training-related injury, such as smoking, should be explored to reduce the risk of training-related injuries. To decrease tobacco use in the Army, smoking cessation classes should be offered during Basic Combat Training to prevent smoking initiation and enable previous smokers to remain tobacco-free beyond Basic Combat Training.

(c) The effectiveness of interventions to reduce stress fractures should be verified in future studies with larger sample sizes and appropriate control of known risk factors. Promising interventions that have been suggested include reducing the amount of running, wearing shock absorbent boots, using orthotic boot inserts, and taking calcium with Vitamin D supplements. Additional examinations of associations between muscle strength, muscular endurance, and stress fractures are also needed. To further explore the relationship between aerobic fitness and stress fractures, more sensitive measures of pre-training physical activity and physical activity during Basic Combat Training are required, as well as markers of bone remodeling.

(d) Quality intervention studies on the strategies to prevent oral and craniofacial injury is needed. Prevention of fighting and motor vehicle crash-related oral-maxillofacial injuries should also be examined as a strategy for reducing military oral-facial injuries.

(4) Injury Policy and Program Evaluation Recommendations

(a) Further investigation with a larger sample size is needed to make recommendations on iron supplementation as an injury prevention strategy in Army Basic Combat Training.

(b) Prescribing running shoes on the basis of plantar shape as a strategy to reduce injuries in U.S. military training is ineffective.

(c) Prior to airborne training, students should improve their aerobic capacity and upper body muscular endurance to prevent injuries. Leaders should also instruct students on use of the parachute ankle brace (PAB) and assure they wear the PAB during training jumps. A proposed modification has been developed by a manufacturer in consultation with the U.S. Army Airborne School to more effectively hold the brace on the boot and reduce heel strap breakages.

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2. PURPOSE. The main purposes of this report are as follows:

a. To present and summarize available medical surveillance data for use in injury prevention program and policy planning, including—

(1) Defining the relative impact of injury compared to other medical conditions among U.S. Army Active Duty personnel in 2008.

(2) Providing Army injury rates and trends from 2000-2008.

(3) Identifying leading injury causes (for injury hospitalizations) and injury types (for hospitalizations and outpatient visits) for 2008.

b. To provide a summary of key results from nondeployment-related analyses, field investigations, and evaluations completed in 2008 by the Injury Prevention Program at the U.S. Army Public Health Command (Provisional) (USAPHC (Prov)), formerly known as the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM).

3. AUTHORITY. Under Army Regulation (AR) 40-5, Section 2-19, the U.S. Army Public Health Command (Provisional) (USAPHC (Prov)), formerly known as the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM), is responsible for providing support for Army preventive medicine activities, to include review and interpretation of surveillance data and identification and characterization of health problems as a foundation for injury prevention planning and policy efforts.

4. BACKGROUND.

a. Injuries impose a major public health problem in the U.S. Armed Forces impacting almost 600,000 Service members annually and leading to over 2.0 million medical encounters.[1] Unintentional injuries are a substantial and highly preventable problem resulting in 38 percent of all deaths of active Service members, during the 1998–2008 period.[2]

b. A public health approach to injury prevention in the military first involves utilizing data to define the magnitude and scope of injuries. Ongoing analysis of surveillance data from the Defense Medical Surveillance System (DMSS) (a central repository of all inpatient and outpatient medical encounters for U.S. military personnel[3]) is essential for monitoring injury trends, detecting unexpected changes in injury occurrence, and establishing injury prevention priorities. A summary of 2008 Army DMSS data is presented in the first section of this report, providing an update on the burden of injuries and diseases, injury rates and trends, and the leading causes of hospitalizations and injury types among nondeployed, Active Duty U.S. Army Soldiers for 2008.

c. Other steps in the public health process include identifying causes and risk factors, developing and testing interventions, and evaluating implemented programs and policies.[4, 5] The second section of this report presents a summary of selected nondeployment injury analyses and a list of peer-reviewed publications produced by the USAPHC (Prov) Injury Prevention Program (IPP) in 2008. The intent of this section is to provide a summary of IPP epidemiologic analyses, field investigations, and evaluations, all of which focus on advancing the knowledge of risk factors and/or interventions addressing key military injury issues.

5. METHODS.

a. <u>Army Injury Surveillance Summary 2008: Death, Hospitalizations, and Outpatient Visits</u>. The first section of this report uses existing medical surveillance data from DMSS[3] to describe the nature of the injury problem in the U.S. Army. Data include all nondeployed U.S. Army Soldiers in the Active Component (hereafter referred to as ‗Active Duty'). Injury data (fatalities, hospitalizations, and outpatient visits) was requested from the Armed Forces Health Surveillance Center in May 2009.

(1) Fatality data contained in the DMSS originate from two data sources: Washington Headquarters Service and the Armed Forces Institute of Pathology. Data received regarding the manner of death fell into one of eight categories: neoplasm, cardiovascular, suicide, homicide, transportation, other accidents, war/legal intervention, and all others. Transportation, other accidents, homicide, and suicide casualties were counted as injury-related deaths in this report.

(2) Hospitalization (inpatient) and outpatient visit data are obtained from DMSS, which draws data from the Military Health System (MHS) Executive Information and Decision Support data systems. Data include treatment received within the MHS, as well as treatment outside the MHS that was paid for by the U.S. military. All data on medical conditions other than injuries are reported according to the 17 major diagnosis code groups as outlined in the International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM).[6]

(3) Injuries resulting in hospitalization and outpatient treatment were identified by ICD-9-CM diagnosis codes from the 800-999 code series for acute (traumatic) injuries and 710-739 code series for injury-related (chronic) musculoskeletal conditions, in concordance with recommendations for monitoring of military injuries.(7) See Appendix B for a complete list of specific ICD-9-CM codes used. Unless otherwise specified, a —60 day" unique hospitalization/ outpatient rule was established for this analysis, in order to reduce the effect of follow-up injury visits and potential overestimation of frequencies and rates. The rule states that multiple visits for the same 3-digit ICD-9-CM diagnosis within 60 days of the initial visit will be counted only once.

(4) The relative burden of injuries and diseases is characterized in this report by three indicators: (1) the total number of medical encounters for each major diagnosis group, (2) the number of individuals with one or more of a particular diagnosis for each major diagnosis group (visits for duplicate diagnoses excluded), and (3) the number of hospital bed days attributed to each major diagnosis group.

(5) Rates are reported for all nondeployed Active Duty Soldiers and all Soldiers-in-training (trainees) for the years 2000–2008. Rates are calculated for *all* injury visits (i.e., follow-up visits included; 60-day rule not applied) that occurred. Rates include acute injuries and injury-related musculoskeletal conditions as described above. Rates were also computed for lower extremity overuse injury visits (see Appendix B for ICD-9-CM codes). Rates were adjusted to remove deployment-related injuries and deployment time; trainee rates were not adjusted for deployment.

(6) Causes of injury hospitalizations are coded at the military treatment facility using the coding scheme outlined in the North Atlantic Treaty Organization (NATO) Standardization Agreement (STANAG) No. 2050, 5th Edition.(8) The coding system is employed for coding all injury hospitalizations in the MHS. (9) The STANAG codes are four-digit codes describing the intent/situation of the injury incident, injury cause, and location at which the injury occurred. This report includes injury hospitalizations coded as —accidental" (a STANAG trauma code, or first digit, of 5-9), hereafter referred to as unintentional injuries. The distribution of the cause of injury (defined using the second through fourth digits of the STANAG code) is presented.

(7) Injury matrices (Barell(10) and injury-related musculoskeletal conditions(11)) were used to further describe acute injuries and injury-related musculoskeletal conditions. The matrices report ICD-9-CM code frequencies by type of injury (listed horizontally, across the top of the chart) and body region (listed vertically, along the left side of the chart). Appendices C and D show the corresponding ICD-9-CM codes represented in each cell of the matrices.

b. Army Injury Epidemiology Project Summaries 2008: Analyses, Investigations, and Evaluations. The second section of this report documents epidemiologic analyses, field investigations, and program evaluations completed by the USAPHC (Prov) Injury Prevention Program (IPP) in 2008.

(1) A summary of findings from select epidemiologic analyses, field investigations, and program evaluations, including USACHPPM technical reports and presentations for calendar year 2008, is presented. Abstracts are displayed with authors and references listed, followed by key figures and/or tables.

(2) A list of citations for all nondeployment-related epidemiologic analyses, field investigations, and program evaluations completed in 2008 by the USAPHC (Prov) IPP is also provided.

6. RESULTS.

a. Army Injury Surveillance Summary: Deaths, Hospitalizations, and Outpatient Visits. This section summarizes medical surveillance data on injuries affecting Active Duty, nondeployed U.S. Army Soldiers.

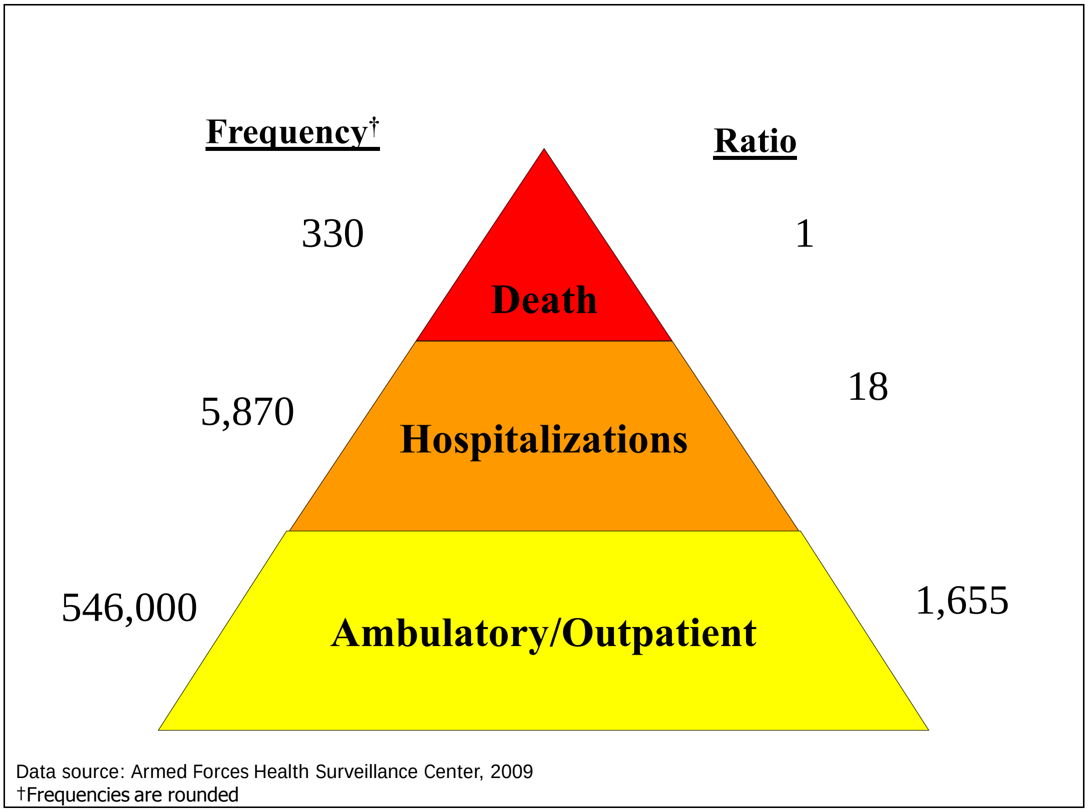
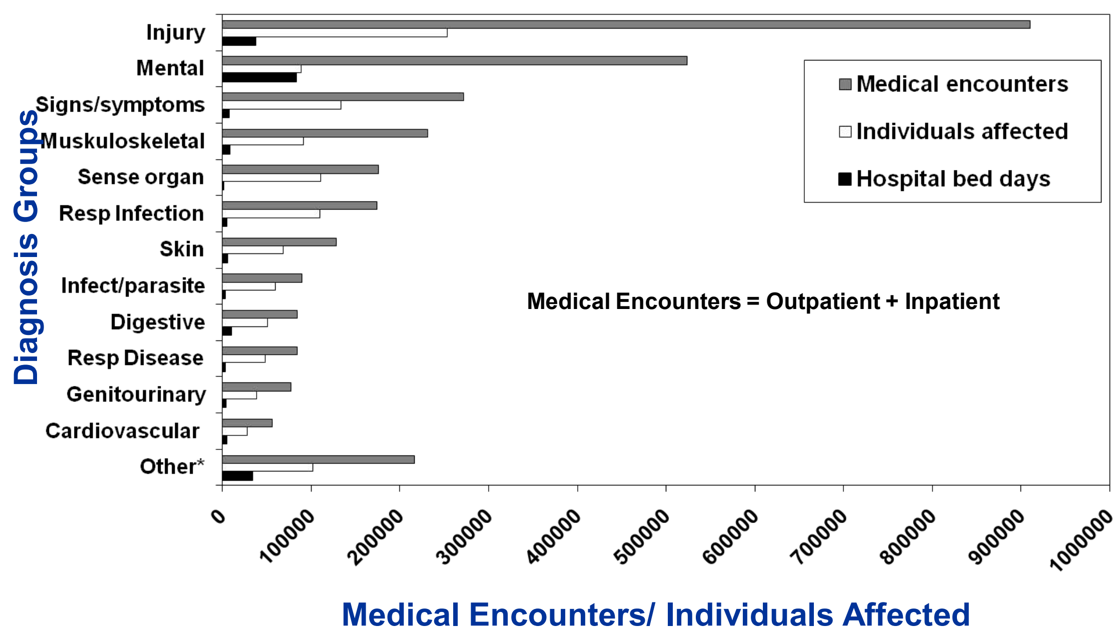


Figure 1. Injury Pyramid, U.S. Army Active Duty, 2008

Figure 1. Notes and Comments—

- Figure 1 provides a summary of accidental injury casualties for 2008.
- In 2008, there were approximately—
  - 330 injury-related deaths.
  - 5,870 injury-related hospitalizations (includes acute injury and injury-related musculoskeletal conditions).
  - 546,000 injury-related outpatient visits.
- For every 1 injury-related death, there were 18 hospitalizations and 1,655 outpatient visits.
- Fatalities have been a major focus of injury prevention activities in the past. As illustrated by these data, however, there are far more injury-related hospitalizations and outpatient visits that occur than deaths. These nonfatal outcomes result in significant losses in duty time and manpower for the Army.



*Includes all diagnosis groups with less than 50,000 medical encounters
Diagnosis group Injury contains both injury and musculoskeletal related injuries
Produced by: Armed Forces Health Surveillance Center; Data source: Defense Medical Surveillance System, 2009

Figure 2. Burden of Injuries and Diseases, U.S. Army Active Duty, 2008

Figure 2. Notes and Comments—

- Figure 2 illustrates the frequency of injuries and disease by primary diagnosis (ICD-9-CM code groups).
- In 2008, there were 3,022,780 medical encounters (hospitalizations and outpatient visits)—
  - Injuries accounted for 30.1 percent of all medical encounters (n=909,989), over 1.7 times as many encounters as the second leading cause, mental disorders (n=523,581, 17.3 percent).
  - Injuries affected 253,694 Soldiers (21.4 percent), almost 2 times more individuals than the second leading diagnosis group, ill-defined signs and symptoms (n= 133,850, 11.3 percent).
  - Mental disorders (n=82,973) required the most hospital bed days followed by injuries (n=36,807).

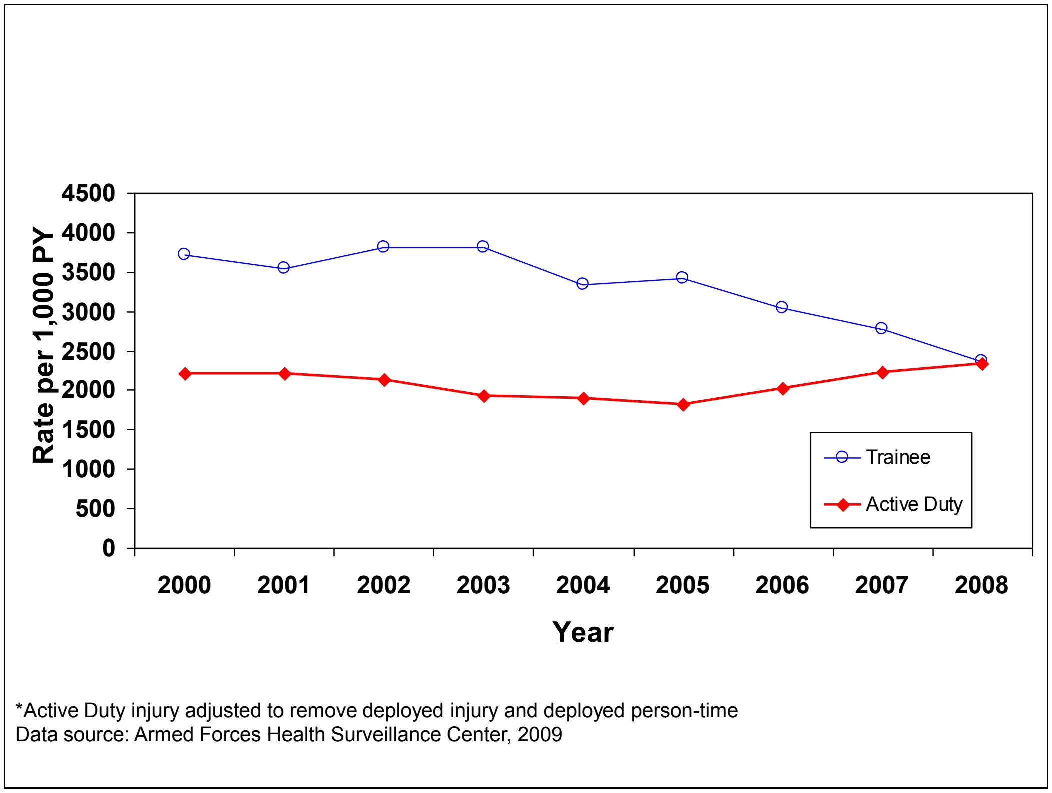


Figure 3. U.S. Army Active Duty vs. Trainee Overall Injury Visit Rates, 2000–2008*

Figure 3. Notes and Comments—

- Figure 3 compares rates of all injury visits among nondeployed Active Duty Soldiers and trainees for 2000–2008.
- The Active Duty injury rate declined slightly from 2000 to 2005 and then increased steadily from 1,819 in 2005 to 2,341 in 2008—a 28.6 percent increase.
- The trainee injury visit rate fluctuated slightly from 2000 to 2003 and then decreased 37.8 percent from 3,807 visits per 1,000 person-years in 2003 to 2,367 visits per 1,000 person-years in 2008.
- The decrease in Army trainee injury rates may be attributable to the Army Training and Doctrine Command standardized physical training program implemented in Basic Combat Training in 2003.[12,13]

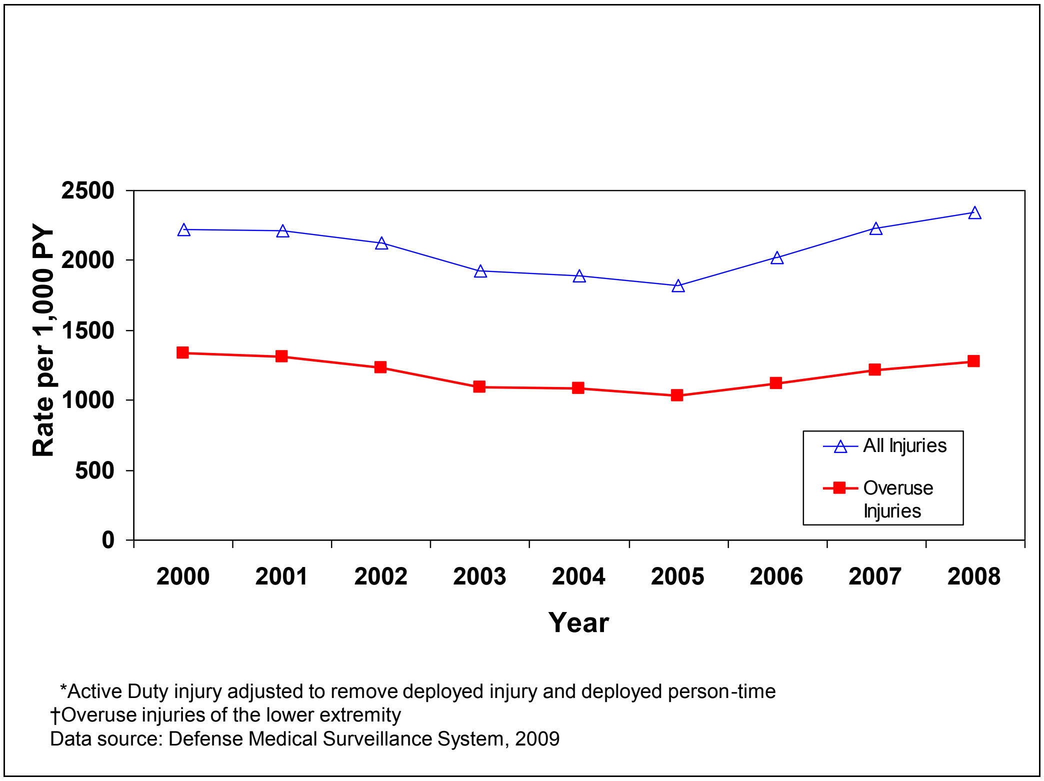
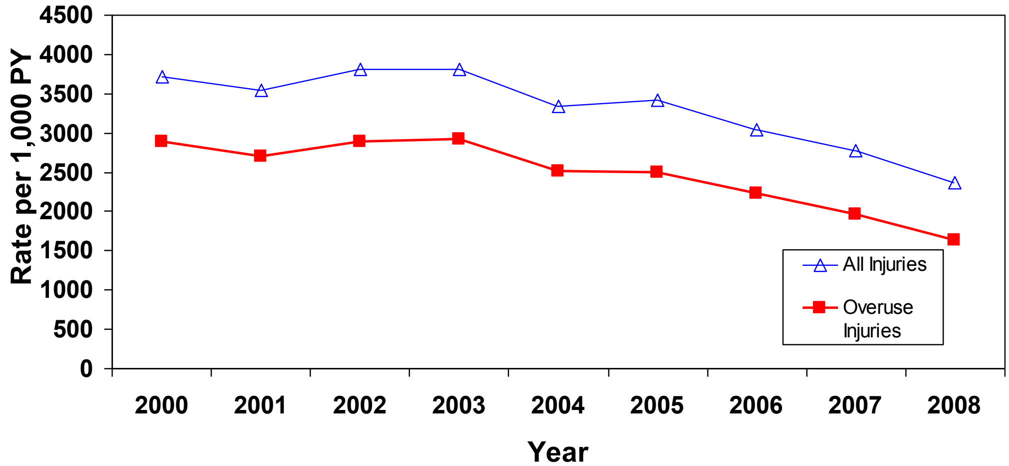


Figure 4. U.S. Army Active Duty Injury and Overuse Injury† Visit Rates, 2000–2008*

Figure 4. Notes and Comments—

- Figure 4 illustrates rates of all injury visits among nondeployed Active Duty Soldiers from 2000–2008.
- Injury visit rates have been consistently over 1,800 visits per 1,000 Soldiers per year throughout this 9-year period.
- Rates of injury visits declined from 2,217 per 1,000 person-years in 2000 to 1,819 per 1,000 person-years in 2005 and then increased steadily to 2,341 per 1,000 person-years in 2008.
- Trends in overuse injury visit rates mirrored overall injury visit rates over the last 9 years, decreasing from 1,334 per 1,000 person-years in the year 2000 to 1,031 per 1,000 person-years in 2005 and then steadily increasing to 1,269 per 1,000 person-years in 2008. The rates are still considered high, exceeding over 1,000 injury visits per 1,000 person-years during this timeframe.
- During 2000–2008, over half of all injury visits were lower extremity overuse injuries. Many of these injuries (25–50 percent) are due to weight-bearing activities such as running and marching.(14-17)



*Active Duty injury adjusted to remove deployed injury and deployed person-time
†Overuse injuries of the lower extremity
Data source: Defense Medical Surveillance System, 2009

Figure 5. U.S. Army Trainee Injury and Overuse Injury† Visit Rates, 2000–2008*

Figure 5. Notes and Comments—

- Figure 5 illustrates rates of all injury visits among Army trainees from 2000–2008.
- The injury visit rate has decreased 36.4 percent from 3,721 visits per 1,000 person-years in 2000 to 2,367 visits per 1,000 person-years in 2008.
- Both ‗overuse injury‘ rates and ‗all injury‘ rates began a steady decrease in 2003. These decreases may be attributable to the Army Training and Doctrine Command standardized physical training program implemented in Basic Combat Training in 2003.[12, 13]
- Trainee overuse injury-visit rates have decreased 43.5 percent over the last 8 years, from 2,886 visits per 1,000 person-years in 2000 to 1,630 visits per 1,000 person-years in 2008.

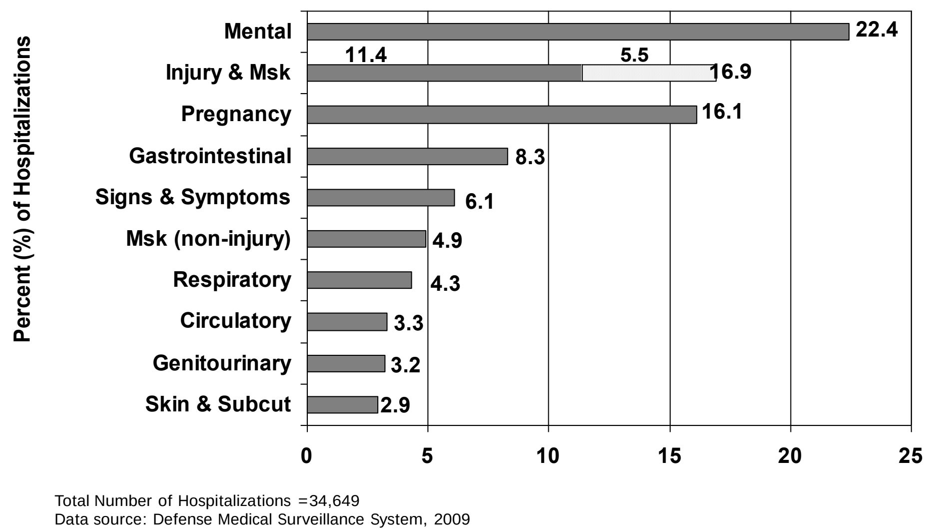


Figure 6. Injuries vs. Illnesses Resulting in Hospitalization, Top 10 ICD-9 Categories, U.S. Army Active Duty, 2008

Figure 6. Notes and Comments—

- Figure 6 displays the proportion of hospital admissions in 2008 by major diagnosis groups.
- Out of 34,649 hospitalizations, three diagnoses groups accounted for over half of all admissions: mental disorders (22.4 percent), injury and injury-related musculoskeletal conditions (16.9 percent), and pregnancy-related issues (16.1 percent).
- In 2008, mental disorders surpassed injuries as a leading cause of hospitalizations.

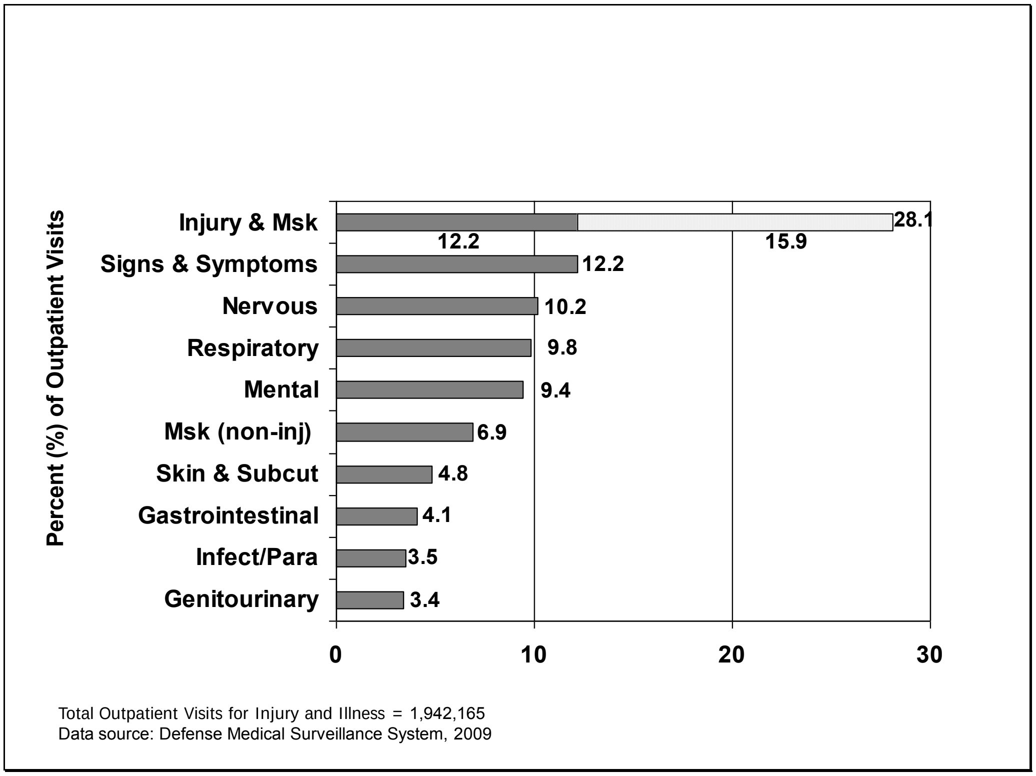
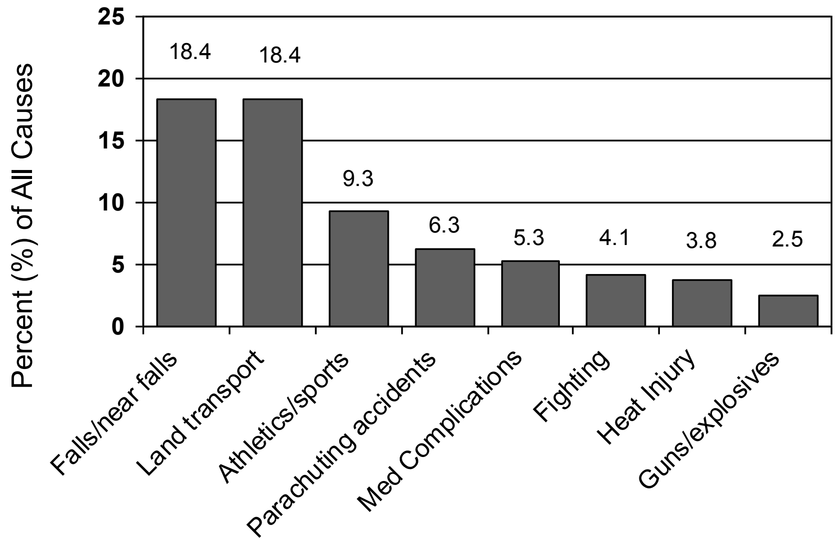


Figure 7. Injuries vs. Illnesses Resulting in Outpatient Visits, Top 10 ICD-9 Categories, U.S. Army Active Duty, 2008

Figure 7. Notes and Comments—

- Figure 7 shows the proportion of outpatient visits in 2008 by major diagnosis groups.
- A total of 1,942,165 unique outpatient visits were made by Active Duty Army personnel; 546,032 were injury related.
- Injuries and injury-related musculoskeletal conditions were responsible for 28.1 percent of outpatient visits, followed by ill-defined signs and symptoms (12.2 percent), nervous system conditions (10.2 percent) and respiratory conditions (9.8 percent).



Source: Defense Medical Surveillance System, 2009
[1]Land transport includes both traffic and nontraffic related and military and nonmilitary related incidents
Total number of cause-coded unintentional injury hospitalizations is 2,315

Figure 8. Leading Causes of Unintentional Injury Hospitalizations by STANAG Code Groupings, U.S. Army Active Duty, 2008†

Figure 8. Notes and Comments—

- Figure 8 illustrates the distribution of the leading causes of unintentional hospitalizations by specific NATO STANAG 2050 injury cause codes.[(8)]
- 18.4 percent of unintentional injury hospitalizations were caused by falls (13.1 percent) or near-falls (twists, slips, trips, or turns—5.4 percent).
- 18.4 percent of unintentional injury hospitalizations were also due to land transport accidents. Land transport-related hospitalizations were, more specifically, attributed to the following: nonmilitary vehicle accidents (14.2 percent), motor vehicle nontraffic accidents (2.0 percent), military vehicle accidents (1.8 percent), and other land transport (0.4 percent). While land transport-related injuries include accidents involving bicycles and railways, the majority of these injuries were linked to motor vehicles.
- 9.3 percent of unintentional injury hospitalizations were due to sports. The leading causes of sports-related injury hospitalizations were as follows: football (2.0 percent of all unintentional injury hospitalizations), basketball (1.6 percent), and wrestling/judo (1.1 percent).

Figure 8. Notes and Comments (continued)—

- Current intervention strategies to address many of these issues are as follows:
    - Motor vehicle accidents—
        - Seatbelt use[18-20]
        - Lower blood alcohol concentration (BAC) laws[21]
        - Increased legal drinking age[21]
    - Sports—
        - Ankle braces[22-26]
        - Breakaway baseball and softball bases[27]
        - Mouthguards for football, basketball[28]
        - Protective eyewear[29-31]
        - Helmets[32]
    - Parachuting—
        - Ankle braces[33-35]
- Other leading causes of accidental injury such as slips, trips, and falls require more research to determine effective interventions.

Table 1. Frequency of Acute Injuries by Location and Diagnosis (Barell Matrix), U.S. Army Active Duty Hospitalizations, 2008

BODY REGION			DIAGNOSIS: Fracture	Dislocation	Sprains/ Strains	Internal	Open Wound	Ampu- tations	Blood Vessel	Contusion/ Superficial	Crush	Burns	Nerves	Unspec	System- wide & late effects	Total	% by body region
Head and Neck	Traumatic Brain Injury (TBI)	Type 1 TBI	44	0	0	183	0	0	0	0	0	0	0	0	0	227	
		Type 2 TBI	20	0	0	145	0	0	0	0	0	0	0	0	0	165	
		Type 3 TBI	10	0	0	0	0	0	0	0	0	0	0	0	0	10	10.7%
	Other Head, Face, Neck	Other head	0	0	0	0	24	0	0	0	0	0	1	33	0	58	
		Face	189	1	0	0	21	0	0	0	0	2	0	0	0	213	
		Eye	0	0	0	0	8	0	0	9	0	0	0	0	0	17	
		Neck	1	0	0	0	5	0	0	0	0	2	1	0	0	9	
		Head, Face, Neck Unspec.	0	0	0	0	0	0	2	26	0	5	0	6	0	39	9.0%
Spine and Back	Spinal Cord (SCI)	Cervical SCI	10	0	0	2	0	0	0	0	0	0	0	0	0	12	
		Thoracic/Dorsal SCI	9	0	0	1	0	0	0	0	0	0	0	0	0	10	
		Lumbar SCI	4	0	0	1	0	0	0	0	0	0	0	0	0	5	
		Sacrum Coccyx SCI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Spine, Back Unspec. SCI	0	0	0	6	0	0	0	0	0	0	0	0	0	6	0.9%
	Vertebral Column (VCI)	Cervical VCI	29	4	11	0	0	0	0	0	0	0	0	0	0	44	
		Thoracic/Dorsal VCI	22	0	1	0	0	0	0	0	0	0	0	0	0	23	
		Lumbar VCI	39	6	2	0	0	0	0	0	0	0	0	0	0	47	
		Sacrum Coccyx VCI	5	0	0	0	0	0	0	0	0	0	0	0	0	5	
		Spine, Back Unspec. VCI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3.2%
Torso	Torso	Chest (thorax)	37	0	1	52	3	0	2	8	0	1	0	0	0	104	
		Abdomen	0	0	0	70	13	0	1	3	0	0	0	0	0	87	
		Pelvis, Urogenital	40	1	0	5	8	0	0	3	1	0	0	0	0	58	
		Trunk	0	0	0	0	1	0	0	3	0	0	0	16	0	20	
		Back, Buttock	0	0	0	0	1	0	0	5	1	0	0	0	0	7	7.4%
Extremities	Upper	Shoulder, Upper Arm	91	30	90	0	9	0	0	3	0	1	0	6	0	230	
		Forearm, Elbow	108	2	2	0	21	0	0	0	1	4	0	0	0	138	
		Wrist, Hand, Fingers	138	8	8	0	82	12	0	4	5	14	0	3	0	274	
		Other & Unspec.	6	0	0	0	3	0	7	3	0	2	10	3	0	34	18.0%
	Lower	Hip	36	4	14	0	0	0	0	1	0	0	0	0	0	55	
		Upper leg, Thigh	72	0	0	0	0	1	0	2	1	1	0	0	0	77	
		Knee	14	54	139	0	0	0	0	2	0	0	0	0	0	209	
		Lower leg, Ankle	381	5	39	0	0	5	0	1	3	4	0	0	0	438	
		Foot, toes	78	4	1	0	8	1	0	2	2	3	0	0	0	99	
		Other & Unspec.	5	0	33	0	65	1	8	3	0	1	0	14	0	130	26.9%
Unclass. by Site	Other, Unspecified	Other/Multiple	4	0	0	0	0	0	0	0	0	0	1	0	0	5	0.1%
		Unspec. Site	7	1	8	7	9	0	0	13	1	6	2	65	0	119	3.2%
	System-wide & late effects		0	0	0	0	0	0	0	0	0	0	0	0	776	776	20.7%
		Total	1,399	120	349	472	281	20	20	91	15	46	15	146	776	3,750	100%
		% Total	37.3%	3.2%	9.3%	12.6%	7.5%	0.5%	0.5%	2.4%	0.4%	1.2%	0.4%	3.9%	20.7%	100%	

*For purposes of classification, head injuries are labeled as Type I TBI if there is recorded evidence of an intracranial injury or a moderate or a prolonged loss of conciousness (LOC) or injuries to the optic nerve pathways. Type 2 includes injuries with no recorded evidence of intracranial injury, and LOC of less than one hour, or LOC of unknown duration, or unspecified level of consciousness. Type 3 TBI includes patients with no evidence of intracranial injury and no LOC.

Prepared by: USACHPPM Injury Prevention Program and Armed Forces Health Surveillance Center

Data source: Defense Medical Surveillance System, 2009

Table 1. Notes and Comments—

- Table 1 uses the Barell Matrix[10] to categorize acute injuries that required hospitalization by injury type and body region.
- In 2008, there were 3,750 acute and traumatic injuries (coded in the 800–900 ICD-9-CM code series) requiring hospitalization.
- The most common types of injury leading to hospital admission were fractures (37.3 percent), internal injuries (12.6 percent) and sprains/strains (9.3 percent).
- Body regions most commonly leading to hospitalization were lower (26.9 percent) and upper extremities (18.0 percent), and the head and neck region (resulting in traumatic brain injury – 10.7 percent).
- Leading specific reasons for hospitalizations included fractures of the lower leg and/or ankle (10.2 percent), fractures of the face (5.0 percent), and internal head wounds (Type 1 traumatic brain injury (TBI)) (4.9 percent).

Table 2. Frequency of Acute Injuries by Location and Diagnosis (Barell Matrix), U.S. Army Active Duty Outpatient Visits, 2008

BODY REGION			Fracture	Dislocation	Sprains/ Strains	Internal	Open Wound	Ampu-tations	Blood Vessel	Contusion/ Superficial	Crush	Burns	Nerves	Unspec	System-wide & late effects	Total	% by body region
Head and Neck	Traumatic Brain Injury (TBI)*	Type 1 TBI	64	0	0	955	0	0	0	0	0	0	0	0	0	1,019	
		Type 2 TBI	85	0	0	3,843	0	0	0	0	0	0	0	0	0	3,928	
		Type 3 TBI	23	0	0	0	0	0	0	0	0	0	0	0	0	23	2.4%
	Other Head, Face, Neck	Other head	0	0	0	0	1,117	0	0	0	0	7	41	1,676	0	2,841	
		Face	1,310	34	82	0	2,739	0	0	0	0	43	0	0	0	4,208	
		Eye	0	0	0	0	230	0	0	3,334	0	96	38	0	0	3,698	
		Neck	2	0	2	0	57	0	0	0	9	28	9	0	0	107	
		Head, Face, Neck Unspec.	0	0	0	0	0	0	20	2,787	15	126	2	765	0	3,715	6.9%
Spine and Back	Spinal Cord (SCI)	Cervical SCI	28	0	0	29	0	0	0	0	0	0	0	0	0	57	
		Thoracic/Dorsal SCI	29	0	0	9	0	0	0	0	0	0	0	0	0	38	
		Lumbar SCI	27	0	0	15	0	0	0	0	0	0	0	0	0	42	
		Sacrum Coccyx SCI	2	0	0	4	0	0	0	0	0	0	0	0	0	6	
		Spine, Back Unspec. SCI	4	0	0	42	0	0	0	0	0	0	0	0	0	46	0.1%
	Vertebral Column (VCI)	Cervical VCI	143	11	5,980	0	0	0	0	0	0	0	0	0	0	6,134	
		Thoracic/Dorsal VCI	255	2	2,462	0	0	0	0	0	0	0	0	0	0	2,719	
		Lumbar VCI	324	10	7,690	0	0	0	0	0	0	0	0	0	0	8,024	
		Sacrum Coccyx VCI	119	25	260	0	0	0	0	0	0	0	0	0	0	404	
		Spine, Back Unspec. VCI	71	1	0	0	0	0	0	0	0	0	0	0	0	72	8.3%
Torso	Torso	Chest (thorax)	600	12	1,510	309	62	0	12	1,595	0	15	1	0	0	4,116	
		Abdomen	0	0	0	109	96	0	0	215	0	15	11	0	0	446	
		Pelvis, Urogenital	299	11	5,154	28	217	0	5	143	7	9	5	0	0	5,878	
		Trunk	6	0	0	0	27	0	0	761	1	23	4	1,030	0	1,852	
		Back, Buttock	0	0	2,740	0	80	0	0	658	2	26	0	0	0	3,506	7.5%
Extremities	Upper	Shoulder, Upper Arm	1,083	2,909	11,423	0	215	11	0	1,102	16	38	0	720	0	17,517	
		Forearm, Elbow	1,478	122	1,088	0	582	28	0	813	29	130	0	0	0	4,270	
		Wrist, Hand, Fingers	5,996	477	6,467	0	4,937	109	0	4,939	348	441	0	904	0	24,618	
		Other & Unspec.	53	0	0	0	166	17	13	910	2	69	480	436	0	2,146	23.1%
	Lower	Hip	266	82	5,397	0	0	0	0	380	3	0	0	0	0	6,128	
		Upper leg, Thigh	398	0	0	0	0	95	0	253	2	32	0	0	0	780	
		Knee	154	3,886	4,535	0	0	0	0	1,725	8	6	0	0	0	10,314	
		Lower leg, Ankle	3,274	50	22,475	0	0	168	0	822	31	78	0	0	0	26,898	
		Foot, toes	3,383	107	3,121	0	865	33	0	4,760	168	90	0	0	0	12,527	
		Other & Unspec.	192	0	19,952	0	1,443	124	27	1,948	7	67	0	2,600	0	26,360	39.5%
Unclass. by Site	Other, Unspecified	Other/Multiple	15	0	0	0	0	0	2	0	0	3	155	0	0	175	0.1%
		Unspec. Site	239	51	6,872	40	1,473	0	8	7,905	41	814	126	521	0	18,090	8.6%
	System-wide & late effects		0	0	0	0	0	0	0	0	0	0	0	0	7,535	7,535	3.6%
		Total	19,922	7,790	107,210	5,383	14,306	585	87	35,050	689	2,156	872	8,652	7,535	210,237	100%
		% Total	9.5%	3.7%	51.0%	2.6%	6.8%	0.3%	0.0%	16.7%	0.3%	1.0%	0.4%	4.1%	3.6%	100%	

*For purposes of classification, head injuries are labeled as Type 1 TBI if there is recorded evidence of an intracranial injury or a moderate or a prolonged loss of consciousness (LOC) or injuries to the optic nerve pathways. Type 2 includes injuries with no recorded evidence of intracranial injury, and LOC of less than one hour, or LOC of unknown duration, or unspecified level of consciousness. Type 3 TBI includes patients with no evidence of intracranial injury and no LOC.

Prepared by USACHPPM Injury Prevention Program and Armed Forces Health Surveillance Center

Data source: Defense Medical Surveillance System, 2009

Table 2. Notes and Comments—

- Table 2 uses the Barell Matrix to categorize outpatient visit injuries by injury type and body region affected.
- In 2008, 210,237 acute injuries (coded in the 800–900 ICD-9-CM code series) required an outpatient hospital visit.
- 51.0 percent of outpatient visits were the result of sprains/strains, 16.7 percent were from contusions/superficial wounds, and 9.5 percent were due to fractures.
- Body regions most affected were lower extremities (39.5 percent), upper extremities (23.1 percent), and the vertebral column (8.3 percent).
- Leading specific reasons for outpatient visits included strains/sprains to the lower leg and/or ankle (10.7 percent) and strains/sprains of the shoulder/upper arm (5.4 percent).
- Not all outpatient visits are less serious than those that require hospitalization. Many of these injuries result in a tremendous number days of limited duty (DLD), resulting in reduced readiness and loss of manpower for the Army. Estimates from clinicians and standard sports medicine texts[36] indicate that—
    - Fractures result in an estimated 30-180 DLD per injury.
    - Dislocations result in an estimated 30-100 DLD per injury.
    - Sprains/strains result in an estimated 7-30 DLD per injury.
- While fractures only account for 9.5 percent of all outpatient visits, they are estimated to account for 41 percent of days of limited duty.
- Dislocations account for 4 percent of all outpatient visits and are estimated to account for approximately 13 percent of days of limited duty.
- Sprains and/or strains account for 51.0 percent of all outpatient visits and are estimated to account for approximately 36 percent of days of limited duty.

Table 3. Frequency of Injury-related Musculoskeletal Conditions by Location and Diagnosis, U.S. Army Active Duty Hospitalizations, 2008

Injury Location				DIAGNOSIS							
				Inflammation and Pain (Overuse)	Joint Derangement	Joint Derangement with Neurological Involvement	Stress Fracture	Sprains/Strains/ Rupture	Dislocation	Total	% by body region
BODY REGION		Vertebral Column	Cervical	17	151	58	0	0	0	226	
			Thoracic/Dorsal	0	5	20	0	0	0	25	
			Lumbar	88	333	36	0	0	0	457	
			Sacrum, Coccyx	1	0	0	0	0	0	1	
			Spine, Back Unspecified	36	14	6	0	0	0	56	41.6%
	Extremities	Upper	Shoulder	146	117	0	0	3	45	311	
			Upper arm, Elbow	21	2	0	0	0	1	24	
			Forearm, Wrist	4	3	0	0	0	0	7	
			Hand	2	0	0	0	1	1	4	18.8%
		Lower	Pelvis, Hip, Thigh	43	24	0	1	0	6	74	
			Knee, Lower leg	86	128	0	0	237	10	461	
			Ankle, Foot	36	56	0	0	2	7	101	34.6%
	Unclassified by Site	Others and Unspecified	Other specified/Multiple	3	0	0	2	2	0	7	
			Unspecified Site	34	0	1	48	0	1	84	5.0%
			Total	517	833	121	51	245	71	1,838	100%
			% Total	28.1	45.3	6.6	2.8	13.3	3.9		

Prepared by USACHPPM Injury Prevention Program and Armed Forces Health Surveillance Center
Data source: Defense Medical Surveillance System, 2009

Table 3. Notes and Comments—

- Table 3 categorizes injury-related musculoskeletal conditions that required hospitalization by injury type and body region affected.[11]
- In 2008, 1,838 hospitalizations due to injury-related musculoskeletal conditions occurred.
- The most common types of injury-related musculoskeletal conditions leading to hospital admission were joint derangement (45.3 percent), inflammation and pain due to overuse (28.1 percent) and sprains/strains/ruptures (13.3 percent).
- The spine/back (41.6 percent) was the body region most affected by injury-related musculoskeletal conditions, followed by lower extremities (34.6 percent) and upper extremities (18.8 percent).
- The leading specific injury-related musculoskeletal conditions were joint derangements of the lumbar spine (18.1 percent), sprains/strains to the knee and/or lower leg (12.9 percent) and joint derangement of the cervical spine (8.2 percent).

Table 4. Frequency of Injury-related Musculoskeletal Conditions by Location and Diagnosis, U.S. Army Active Duty Outpatient Visits, 2008

Injury Location				DIAGNOSIS							
				Inflammation and Pain (Overuse)	Joint Derangement	Joint Derangement with Neurological Involvement	Stress Fracture	Sprains/Strains/ Rupture	Dislocation	Total	% by body region
BODY REGION		Vertebral Column	Cervical	13,106	1,873	2,276	0	0	0	17,255	
			Thoracic/Dorsal	0	289	3,361	0	0	0	3,650	
			Lumbar	50,389	6,602	2,133	0	0	0	59,124	
			Sacrum, Coccyx	1,964	0	0	0	0	0	1,964	
			Spine, Back Unspecified	16,471	2,057	307	84	0	0	18,919	33.1%
	Extremities	Upper	Shoulder	32,314	2,282	0	0	1,085	591	36,272	
			Upper arm, Elbow	5,287	76	0	0	0	3	5,366	
			Forearm, Wrist	5,999	227	0	17	0	9	6,252	
			Hand	3,312	56	0	0	196	13	3,577	16.9%
		Lower	Pelvis, Hip, Thigh	12,769	260	0	39	97	6	13,171	
			Knee, Lower leg	64,782	6,829	0	1,832	2,953	132	76,528	
			Ankle, Foot	44,249	2,733	0	628	104	33	47,747	45.1%
	Unclassified by Site	Others and Unspecified	Other specified/Multiple	1,123	34	0	137	29	5	1,328	
			Unspecified Site	8,789	87	1,291	3,417	128	3	13,715	4.9%
			Total	260,554	23,405	9,368	6,154	4,592	795	304,868	100%
			% Total	85.5	7.7	3.1	2.0	1.5	0.3		

Prepared by USACHPPM Injury Prevention Program and Armed Forces Health Surveillance Center
Data source: Defense Medical Surveillance System, 2009

Table 4. Notes and Comments—

- Table 4 categorizes injury-related musculoskeletal conditions that resulted in an outpatient visit by injury type and body region affected.[(11)]
- In 2008, 304,868 injury-related musculoskeletal conditions outpatient visits occurred (coded in the 710-739 ICD-9-CM series).
- Most musculoskeletal conditions outpatient visits involved inflammation and pain due to overuse (85.5 percent), followed by joint derangement (7.7 percent), and joint derangement with neurological involvement (3.1 percent).
- Lower extremities (45.1 percent) was the body region most often treated on an outpatient basis, followed by the spine/back (33.1 percent), and upper extremities (16.9 percent).
- The leading specific injury-related musculoskeletal conditions were inflammation and pain (overuse) to the knee and/or lower leg (21.2 percent), inflammation and pain (overuse) to the lumbar spine (16.5 percent) and inflammation and pain (overuse) to the ankle and/or foot (14.5 percent).
- Many outpatient injury-related musculoskeletal conditions are just as serious as those that require hospitalization. These injuries can result in a tremendous number of DLD, resulting in loss of manpower for the Army.[36]
    - Stress fractures account for an estimated 75 DLD per injury
    - Joint derangements account for an estimated 21 DLD per injury
    - Inflammation and pain associated with overuse, joint derangement with neurological involvement and sprains/strains account for an estimated 14 DLD per injury.
- Stress fractures only account for 2 percent of all injury-related musculoskeletal condition outpatient visits, yet they account for an estimated 10 percent of days of limited duty.
- Joint derangements account for 8 percent of all injury-related musculoskeletal condition outpatient visits and an estimated 10 percent of all days of limited duty.
- Inflammation and pain associated with overuse accounts for 85 percent of all injury-related musculoskeletal condition outpatient visits and an estimated 76 percent of days of limited duty.

b. Army Injury Epidemiology Project Summaries 2008: Analyses, Investigations, and Evaluations. This section features a summary of nondeployment investigations and evaluations completed by the USAPHC (Prov) (formerly USACHPPM) Injury Prevention Program in 2008.

(1) *Setting Priorities in Preventive Medicine*. (Prepared by: Canham-Chervak M and Jones BH. Presented at the Annual Force Health Protection Conference, August 2008.)

Consistent progress toward reducing overall rates of disease and injury in U.S. military populations requires a long-term plan, with priorities that are selected using a systematic, objective, evidence-based process. The USAPHC (Prov) Injury Prevention Program and Johns Hopkins Center for Injury Research and Policy collaborated to develop such a process. Medical surveillance data were reviewed to establish the magnitude of health problems and criteria were developed to rank these problems based on their importance, preventability, feasibility of implementing programs/policies, and potential for evaluating programs/policies (Figure 9). This exercise produced a prioritized list of the following U.S. Army‘s top ten injury problems: physical training, privately owned motor vehicle accidents, athletics/sports, excessive heat, military motor vehicle accidents, falls/jumps, marching/drilling, lifting/pushing/pulling, military air transport accidents, and excessive cold. This list is currently used to direct USAPHC (Prov) injury prevention efforts. The process could be adapted to assess and prioritize injuries and other public health problems affecting the Army and other communities.

USACHPPM Criteria for
Prioritizing Injury Programs & Policies

Purpose: This scorecard is a tool that provides a systematic means of assessing and quantifying the state of prevention programs and policies for a specific injury problem. The criteria and scoring were developed by military and civilian injury researchers, medical providers, and safety experts. Comparing total scores obtained using this scorecard can assist with injury program and policy prioritization efforts.

How to use this scorecard: Complete a scorecard for each injury problem under consideration. First, provide a **preliminary rating** for each of the *Considerations* listed under each criterion. Then, using the preliminary ratings as a guide, assign a **final score** for each criterion. For criteria B, C, and D, assign a final score from 1-10 (1=lowest score, 10= highest score). For criterion E, assign a final score from 1-5 (1= lowest score, 5=highest score). Adding the final scores will provide a **total score**. A perfect score on all criteria would result in a total score of 35.

Criterion	Preliminary rating	Final score
A. PROGRAM OR POLICY IS CONSISTENT WITH MISSION	[ ] YES [ ] NO	If YES – Continue with scoring. If NO – Stop here.
B. IMPORTANCE OF PROBLEM TO FORCE HEALTH & READINESS *Considerations*: 1. Magnitude and severity of problem (consider its effect on personnel readiness) 2. Cost of the problem (consider training, property, and personnel costs) 3. Size and/or vulnerability of population at risk 4. Degree of concern (consider command concern, public concern, visibility of problem)	 1. [ ] Low [ ] Medium [ ] High 2. [ ] Low [ ] Medium [ ] High 3. [ ] Low [ ] Medium [ ] High 4. [ ] Low [ ] Medium [ ] High	**(10 points; 1=low, 10=high)**
C. PREVENTABILITY OF PROBLEM (10 points) *Considerations*: 1. Cause(s) are identifiable. 2. Risk factors are modifiable. 3. Proven prevention strategies exist. 4. Prevention strategies can be designed.	 1. [ ] Low [ ] Medium [ ] High 2. [ ] Low [ ] Medium [ ] High 3. [ ] Low [ ] Medium [ ] High 4. [ ] Low [ ] Medium [ ] High	**(10 points; 1=low, 10=high)**
D. FEASIBILITY OF PROGRAM OR POLICY (10 points) *Considerations*: 1. Existence of infrastructure to support implementation of the program or policy (consider medical staff & facilities, safety staff & resources, cadre availability). 2. Adequacy of funding to support implementation. 3. Authority to implement the program or policy is held or obtainable by the implementing organization(s). 4. Program or policy will not undermine essential missions. 5. Political and cultural acceptability of program or policy. 6. Accountability & responsibility for implementation exists or can be established.	 1. [ ] Low [ ] Medium [ ] High 2. [ ] Low [ ] Medium [ ] High 3. [ ] Low [ ] Medium [ ] High 4. [ ] Low [ ] Medium [ ] High 5. [ ] Low [ ] Medium [ ] High 6. [ ] Low [ ] Medium [ ] High	**(10 points; 1=low, 10=high)**
E. EVALUATION OF PROGRAM OR POLICY (5 points) *Considerations*: 1. Ability to evaluate effects of program or policy exists (consider if a metric is possible). 2. Benefits of program or policy outweigh the costs of implementation.	 1. [ ] Low [ ] Medium [ ] High 2. [ ] Low [ ] Medium [ ] High	**(5 points; 1=low, 5=high)**
TOTAL SCORE		

Figure 9. USAPHC (Prov) Criteria for Prioritizing Programs and Policies

(2) *Establishing Evidence-Based Injury Prevention Priorities: An Example Process.* (Prepared by: Canham-Chervak M, Canada S, and Jones BH. Presented at the Department of Defense Forum, National Safety Council 2008 Congress & Expo.)

To identify injury priorities for the USAPHC (Prov) Injury Prevention Program, twelve injury experts convened for a 1-day workshop. Existing criteria to prioritize injury programs and policy initiatives were reviewed. Five militarily relevant criteria were added, and some selected previously established criteria were reworded. Criteria were grouped into four categories: magnitude of the problem, preventability of the problem, feasibility of establishing programs or policies, and ability to evaluate. A scoring system was defined; 10 points each for the first three categories and 5 for the final category.

Subsequently, via e-mail, participants scored 25 unintentional injury issues using these criteria and applicable surveillance data that had been presented during the workshop. Injury issues were ranked according to mean scores, harmonic mean scores, and the sum across criteria of weighted, normalized median scores. Mean scores ranged from 7.6–25.7 (SD±5.2); harmonic mean scores ranged from 9.8–26.2 (SD±4.6); sums of weighted, normalized median scores ranged from 31.4–78.6 (SD±14.3). All three ranking procedures resulted in the same top two injury issues: physical training injuries and motor vehicle accidents. The following causes of injury also appeared in the top ten, regardless of ranking procedure (listed in rank order by mean scores): physical training, privately owned vehicle accidents, athletics/sports, excessive heat, military motor vehicle accidents, falls/jumps, marching/drilling, lifting/pushing/pulling, military air transport accidents, and excessive cold (Table 5). This systematic, objective process produced a prioritized list of the U.S. Army‘s top ten injury issues that is being used to direct injury prevention efforts at the USAPHC (Prov). The process reduces subjectivity and conflicts of interest in setting priorities and could be adapted for use in safety and public health prevention planning in other military organizations and communities.

Injury cause	Mean score (rank)	Harmonic mean score	Weighted, normalized median score
Physical training	25.7 (1)	26.2 (1)	78.6 (1)
Privately owned vehicle accidents	22.6 (2)	25.0 (2)	74.3 (2)
Athletics/sports	21.8 (3)	22.3 (3)	62.9 (6)
Excessive heat	21.1 (4)	22.0 (4)	68.6 (3)
Military motor vehicle accidents	21.0 (5)	21.5 (5)	67.1 (4)
Falls/jumps	20.5 (6)	21.1 (6)	60.0 (7)
Marching/drilling	20.3 (7)	20.9 (7)	64.3 (5)
Lifting/pushing/pulling	20.0 (8)	20.7 (8)	60.0 (7)
Military air transport accidents	20.0 (8)	20.4 (9)	57.1 (10)
Excessive cold	18.0 (10)	18.8 (10)	58.6 (9)

(3) *The Five Essential Elements of the Public Health Process/Practice.* (Prepared by: Jones BH. Presented by E Hoedebecke at the Annual Force Health Protection Conference, August 2008.)

Each element or activity of most public health/preventive medicine programs is so busy responding to unit, installation, or Service needs and requests that it is easy to lose sight of the other elements of the public health process. The five elements of the public health process include: (1) surveillance, (2) research and field investigation, (3) intervention trials, (4) program and policy implementation, and (5) evaluation of strategies, programs and policies. The USAPHC (Prov) Injury Prevention Program engages in each element of the process. Resources, including consulting, are available for use by installation preventive medicine personnel.

(4) *Putting the Public Health Process into Practice: Examples of Public Health Program and Policy Evaluations.* (Prepared by: Knapik JJ, Jordan N, and Coldren R. Presented at the Annual Force Health Protection Conference, August 2008.)

Examples of recent injury program evaluations include modifications to physical training and reintroduction of parachute ankle braces (PAB). The Basic Combat Training physical training was modified by reducing running, gradual progressive overload, and increasing exercise variety. Injury risk was substantially reduced (risk ratio (control/intervention) =1.6), and the program was mandated for implementation by the Army Training and Doctrine Command. The PAB was evaluated, found to reduce ankle injuries by 85 percent, and was adopted for use in 1994. In 2001, use was discontinued because of operational concerns. In 2005–2006, evaluation at the Airborne School showed those who did not wear the PAB experienced twice as many ankle injuries (risk ratio (control-No PAB/intervention-PAB)=1.9) and did not increase other lower body injuries or complicate parachute entanglements.

(5) *Approaches to Injury Surveillance at the Local Level.* (Prepared by: Hauret, K. Presented at the Annual Force Health Protection Conference, August 2008.)

Preventive medicine and public health personnel at local military treatment facilities must be constantly vigilant of the health status of their patient population. They need to be able to identify changes in the signs and symptoms for which their patients are seeking medical care. Even subtle changes in the presentation of patients from their community could provide the first alert for a possible disease or injury outbreak. As the first step in the public health process, medical surveillance is used to identify emerging public health issues. These emerging issues can be disease or injury related. Surveillance data can also assist preventive medicine and public health personnel to prioritize their efforts in addressing current and emerging injury issues. Surveillance systems at the Armed Forces Health Surveillance Center and the U.S. Army Public Health Command (Provisional) can be utilized to monitor injury trends at the installation level by preventive medicine and public health personnel to monitor injury occurrences and be alerted of emerging injury problems.

(6) *Department of Defense Injury Burden: A Summary of Medical Surveillance Data.* (Prepared by: Canham-Chervak M, Canada S, and Jones BH. Presented at the Annual Force Health Protection Conference, August 2008.)

Injuries are a leading cause of death, disability, inpatient, and outpatient care for all Services. In 2006, there were over 2,000,000 injury-related medical encounters affecting approximately 900,000 Service members (Figure 10). Active Duty injury rates in 2006 ranged from 1,170/1,000 personnel (Navy) to 2,183/1,000 personnel (Army). Sprains/strains (48.8 percent), contusions (16.3 percent), and fractures (9.8 percent) were the leading injury types treated in outpatient settings. Fractures (39.6 percent), system-wide and late effects (15.9 percent), and internal injuries (12.3 percent) were the leading hospitalized injuries for Active Duty Service members in 2006. The top three causes of hospitalized injuries were privately owned vehicle accidents (15.4 percent), falls/jumps (13.4 percent), and sports (13.1 percent). Medical surveillance data such as these provide a means of tracking injury rates, establishing leading causes, and providing information needed to prioritize Department of Defense injury prevention efforts.

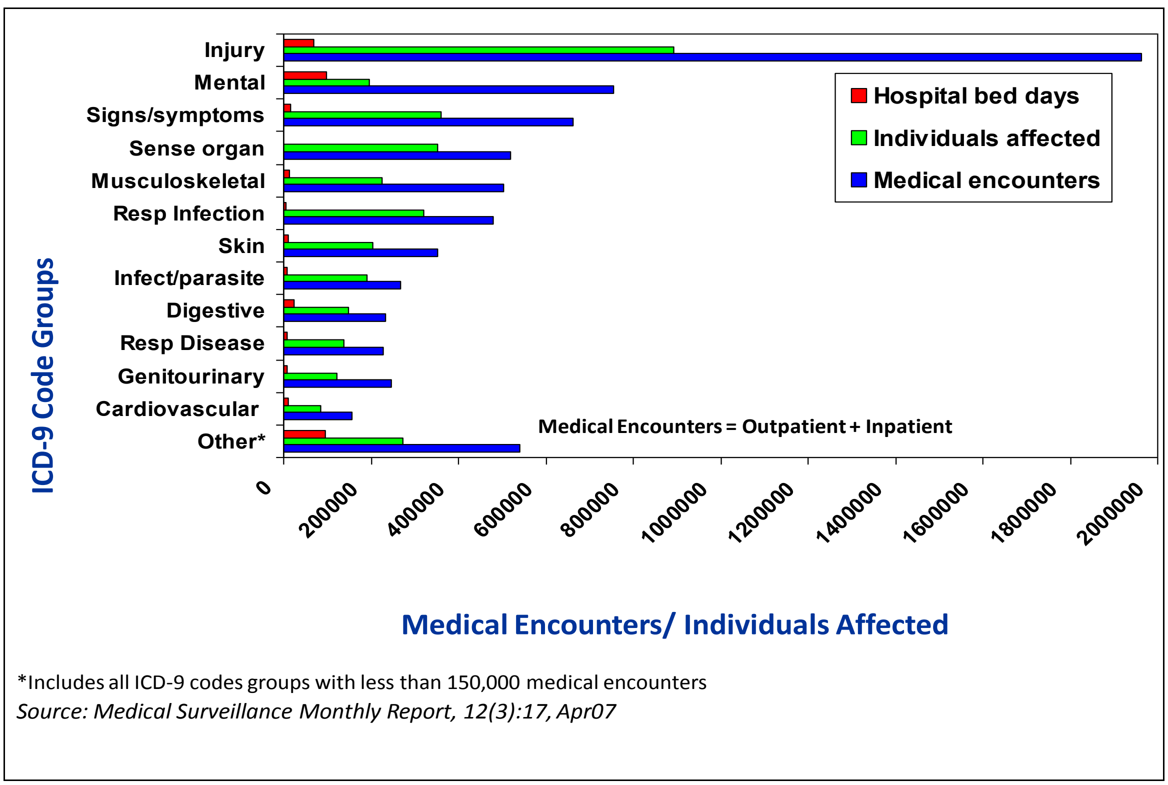


Figure 10. Burden of Injuries and Diseases, Active Duty DOD, 2006

(7) *Injury-Related Musculoskeletal Conditions: An Under-Recognized Injury Problem among Military Personnel.* (Prepared by: Hauret K, Canham-Chervak M, and Canada S. Presented at the Annual Force Health Protection Conference, August 2008.)

Though injuries are recognized as a leading health problem in the military, the size of the problem is underestimated when only acute traumatic injuries are considered. Injury-related musculoskeletal conditions are common in this young, active population. Many of these conditions involve physical damage caused by micro-trauma (overuse) in recreation, sports, training, and job performance. The purpose of this analysis was to determine the incidence of injury-related musculoskeletal conditions in the military Services (2006) and to describe a standardized format to categorize and report them. The subset of musculoskeletal diagnoses found to be injury-related in previous military investigations was identified. Musculoskeletal injuries among nondeployed Active Duty Service members in 2006 were identified from military medical surveillance data. A matrix was used to report and categorize these conditions by injury type and body region. There were 743,547 injury-related musculoskeletal conditions in 2006 (outpatient and inpatient, combined), including primary and nonprimary diagnoses (Table 6). In the matrix, 82 percent of injury-related musculoskeletal conditions were classified as inflammation/pain (overuse), followed by joint derangements (15 percent) and stress fractures (2 percent). The leading body region categories were knee/lower leg (22 percent), lumbar spine (20 percent), and ankle/foot (13 percent). When assessing the magnitude of the injury problem in the military Services, injury-related musculoskeletal conditions should be included. When these injuries are combined with acute traumatic injuries, there are almost 1.6 million injury-related medical encounters each year. The matrix provides a standardized format to categorize these injuries, make comparisons over time, and focus prevention efforts on leading injury types and/or body regions.

Table 6. Injury-Related Musculoskeletal Condition Matrix for the Active Duty Air Force, Army, Marines, and Navy, 2006[a-d]

Body Region			Inflammation and Pain (Overuse)	Joint Derangement	Joint Derangement with Neurological Involvement	Stress Fracture	Sprain/Strain/ Rupture	Dislocation	Total	Total Percent
Spine and Back	Vertebral Column	Cervical	36,932	5,390	7,972	0	0	0	50,294	6.8%
		Thoracic/Dorsal	0	751	15,244	0	0	0	15,995	2.2%
		Lumbar	114,562	18,078	12,684	0	0	0	145,324	19.5%
		Sacrum Coccyx	4,720	0	0	0	0	0	4,720	0.6%
		Spine, Back Unspecified	72,755	7,283	2,831	283	0	0	83,152	11.2%
Extremities	Upper	Shoulder	54,460	7,014	0	0	2,644	2,368	66,486	8.9%
		Upper arm, Elbow	7,392	313	0	18	0	33	7,756	1.0%
		Forearm, Wrist	18,037	691	0	37	0	28	18,793	2.5%
		Hand	11,146	320	0	0	657	50	12,173	1.6%
	Lower	Pelvis, Hip, Thigh	26,509	394	0	179	229	23	27,334	3.7%
		Knee, Lower leg	140,161	17,490	0	6,800	1,335	535	166,321	22.4%
		Ankle, Foot	89,598	6,498	0	0	371	229	96,696	13.0%
Unclassified by Site	Others and Unspecified	Other specified/Multiple	5,882	273	0	404	114	16	6,689	0.9%
		Unspecified Site	29,690	365	5,048	6,261	430	20	41,814	5.6%
		Total	611,844	64,860	43,779	13,982	5,780	3,302	743,547	
		Total Percent	82.3%	8.7%	5.9%	1.9%	0.8%	0.4%		100%

Legend:
[a] Includes injury-related musculoskeletal conditions from outpatient visits and hospitalizations; primary and non-primary diagnoses were included.
[b] Medical encounters (outpatient visits or hospitalizations) for the same injury-related musculoskeletal condition diagnosis (ICD-9-CM) within 60 days of the first hospitalization or outpatient visit were excluded to minimize duplicate counts of the same injury.
[c] Source: Defense Medical Surveillance System
[d] Prepared by the Army Medical Surveillance Activity, USACHPPM (October 8 2007)

(8) *Oral-Maxillofacial Injuries among Active Duty U.S. Military Personnel, 1996–2005*. (Prepared by: Mitchener TA, Canham-Chervak M, and Jones BH, 2008. Presented by M Canham-Chervak at the National Occupational Injury Research Symposium.)

In civilian populations, data suggest that over 10 percent of emergency room visits are due to craniofacial injuries. Because of the lack of epidemiologic studies, the size and scope of oral-facial injuries in the military is not well understood. This analysis reports Department of Defense frequencies, distributions, and rates of oral-facial injuries and causes, and recommends approaches to improving surveillance, research, and prevention. Active Duty military personnel, who sought inpatient or outpatient treatment in medical facilities for one or more injuries of the oral-facial region from 1996–2005, were identified in the Defense Medical Surveillance System using ICD-9-CM diagnosis codes associated with oral-maxillofacial injuries. The ICD-9-CM diagnosis codes were further divided into two categories: oral-facial wounds and oral-facial fractures. Multiple visits for the same oral-facial injury diagnosis within 60 days of the initial visit were excluded to reduce the effect of follow-up visits. The oral-maxillofacial fracture rates for men were consistently 1.5 to 2 times higher than those for women. Unlike fractures, wound rates for men and women were similar over time. Active Duty personnel under age 25 had the highest rates of both oral-maxillofacial fractures and wounds. Fighting (13.5 percent) and land transport accidents (8.4 percent) were the leading causes of oral-maxillofacial injury hospitalizations in 2005, followed by war-related incidents (8 percent), gun/explosives training and handling (8 percent), and falls (5.1 percent) (Figure 11). The military would benefit from a system of surveillance that incorporates not only medical care data but also dental care data. There is also a need for additional quality intervention studies on the strategies to prevent oral and craniofacial injury. Prevention of fighting and motor vehicle crash related oral-maxillofacial injuries should be looked at as a strategy for reducing military oral-facial injuries.

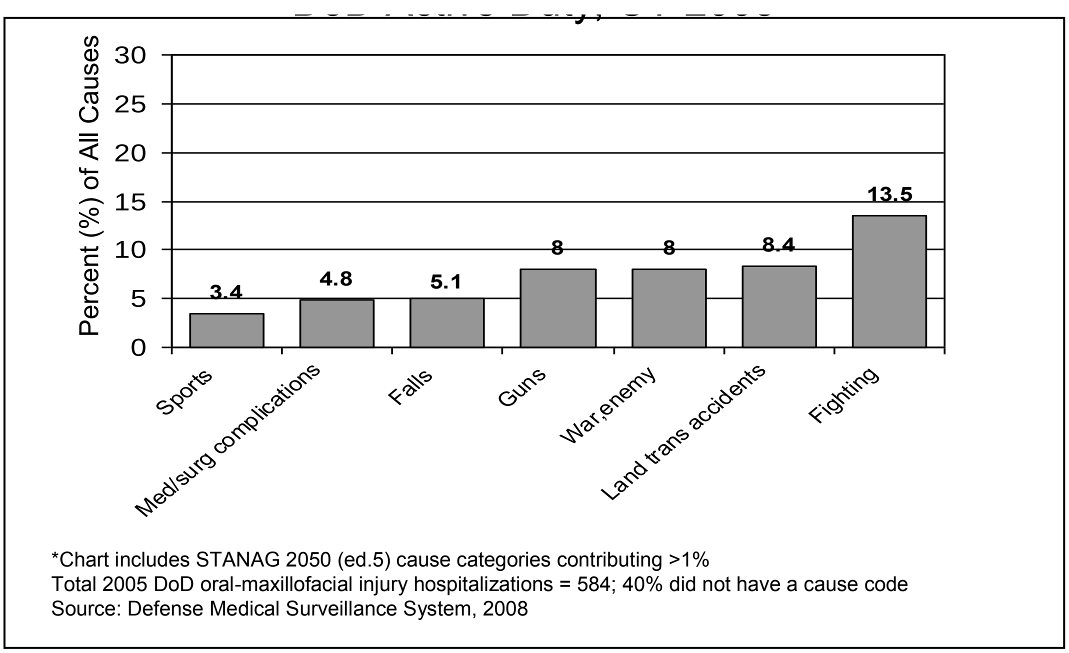


Figure 11. Causes of Oral-Maxillofacial Injury Hospitalizations, DOD Active Duty, 2005

(9) *The Epidemiology of Falls, Slips, and Trips in the U.S. Army.* (Prepared by: Canham-Chervak M, Hauret K, and Jones BH. Presented at the Ergonomics Society Annual Conference International Symposium on Slips, Trips, and Falls.)

Analysis of medical surveillance and administrative data has demonstrated that slips, trips, and falls (STF) contribute significantly to the U.S. Army injury burden. From 2000–2006, STF were a leading cause of Army injury hospitalizations, accounting for 16.2–17.9 percent (n=399-507) of all injury hospitalizations annually. Rates of STF-related injuries were 98 to 114 per 100,000 personnel per year. Among categories of STF (falls/jumps from ladders, falls/jumps from different level, falls/jumps from same level, twists/turns/slips), rates for ‗falls from ladders‘ were consistently the lowest, ranging from 11 to 15 per 100,000 per year, and rates for ‗falls from a different level‘ were typically highest, ranging from 33 to 41 per 100,000 per year (Figure 12). Falls/jumps are also the leading causes of nonbattle injuries among troops in deployed settings. Among U.S. Army personnel in Operation Iraqi Freedom, 24.7 percent (n=1,446) of nonbattle injuries requiring air medical evacuation between March 2003–June 2006 were due to STF. Nearly 30 percent (n=419) of these were attributed to STF from stationary vehicles. Such injuries, whether suffered at home or overseas, result in unnecessary costs including medical expenses, lost work time, and manpower reductions. Because of the magnitude and severity of the problem with falls, additional research on risk factors, causes, and interventions to prevent falls among working-age populations is needed.

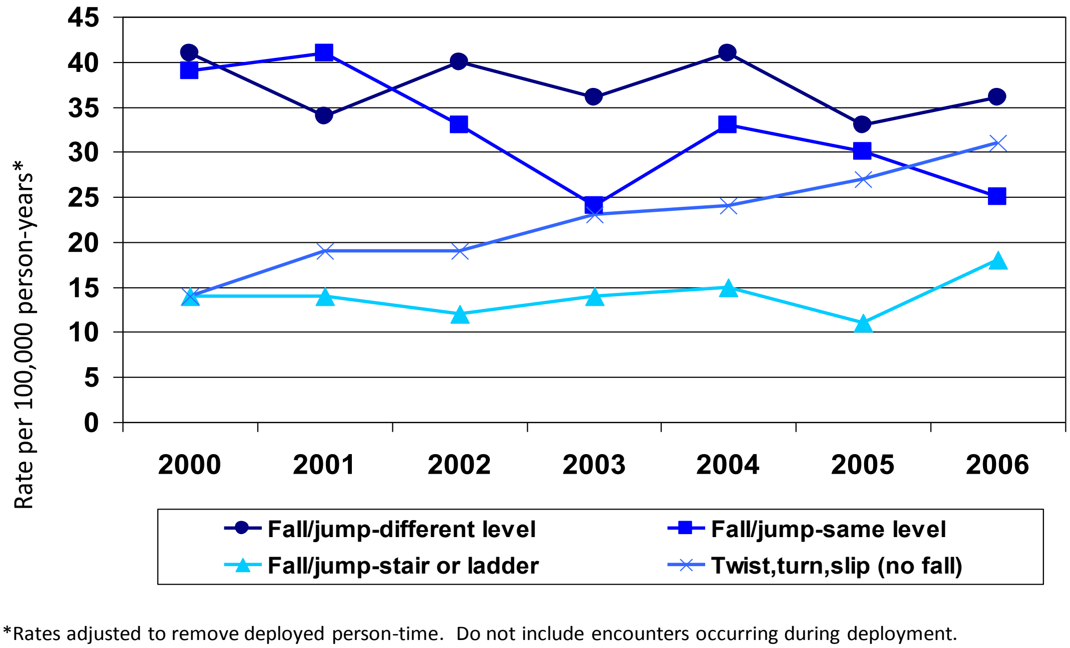


Figure 12. Rates of Fall-Related Hospitalizations by Fall Type,
U.S. Army Active Duty, 2000-2006

(10) *The Association of Health Risk Behaviors, Risk-Taking, and Injuries during Army Basic Combat Training*. (Prepared by: Canham-Chervak M, Hauret K, Canada S, Knapik J, and Jones BH. Presented at the Joint Accessions Research & Best Practices Symposium.)

While demographic and physiologic risk factors associated with military training-related injury have been well described, knowledge of behavioral risk factors associated with training-related injury is limited. This study investigated the association of health risk behaviors with injuries sustained during Army Basic Combat Training (BCT) in 1,156 male and 746 female Soldiers. Self-reported questionnaire data on prior health risk behaviors collected from the Army Recruit Assessment Program Pilot Survey were linked to Army Physical Fitness Test results and medical data on injuries occurring during the 9-week BCT period. Multivariate survival analysis was used to model the association of training-related injury with a combined risk-taking index consisting of five individual health risk behaviors (cigarette use, smokeless tobacco use, alcohol use, weight control practices, and diet/lifestyle choices). Analysis was conducted separately for males and females, and models controlled for demographic, physical fitness, and physiologic characteristics. Cumulative injury incidence was 4.2 trainees/1,000 trainee-days for men and 9.3 trainees/1,000 trainee-days for women. Males in both the lowest (hazard ratio (HR)=1.73, 95 percent confidence interval (CI): 1.47-2.05) and highest (HR=1.92, 95 percent CI: 1.57-2.34) combined risk-taking index categories had greater risk of training-related injury compared to persons within one standard deviation of the mean combined risk index score (Table 7). Cigarette use was independently associated with training-related injury; males in the medium risk cigarette use index category had 1.8 times the risk of a training-related injury compared to the low risk category (HR=1.77, 95 percent CI: 1.31-2.40). An association between the combined risk-taking index and injury was not seen among females. However, females in the high risk cigarette use category (HR: 1.53, 95 percent CI: 1.10-2.12) and females in the medium (HR: 1.08, 95 percent CI: 1.03-1.14) and high risk (HR: 1.52, 95 percent CI: 1.21-1.93) diet/lifestyle categories had higher risk of training-related injury compared to females in low risk categories. In summary, among females, injury risk was associated with individual health risk behaviors related to cigarette use and diet/lifestyle choices. Among males, risk-taking was associated with training-related injury while controlling for known risk factors. These data suggest that training-related injury risk, particularly among male Soldiers, is influenced by risk-taking tendency, a potentially modifiable risk factor.

Table 7. Association of Health Risk Behaviors and Risk of Injury during Army Basic Combat Training, by Gender*

Variable	Male		Female	
	Categories	**Hazard Ratio (95% CI)**	**Categories**	**Hazard Ratio (95% CI)**
Combined risk taking-index	**Lowest risk-taking (>1 SD† below mean)**	1.7 (1.4-2.0)	**Lowest risk-taking (>1 SD below mean)**	1.7 (1.4-2.0)
	Average risk-taking (1 SD around the mean)	ref	**Average risk-taking (1 SD around the mean)**	ref
	Higher risk-taking (1-2 SD above the mean)	1.1 (0.7-1.7)	**Higher risk-taking (1-2 SD above the mean)**	1.1 (0.9-1.3)
	Highest risk-taking (2 SD above the mean)	1.8 (1.5-2.3)	**Highest risk-taking (2 SD above the mean)**	0.8 (0.6-1.0)
Cigarette Use	**Low risk (nonsmokers)**	ref	**Low risk (nonsmokers)**	ref
	Medium risk	1.7 (1.3-2.2)	**Medium risk**	1.1 (1.0-1.1)
	High risk	1.5 (0.8-2.6)	**High risk**	1.5 (1.2-2.0)
Dietary/lifestyle choices	**Low risk**		**Low risk**	ref
	Medium risk		**Medium risk**	1.1 (1.0-1.1)
	High risk		**High risk**	1.5(1.2-2.0)

Note:
*For males, controlled for education, run time, age, and ethnicity; for females, controlled for run time, situps, age, and body mass index
†SD refers to standard deviation

(11) *Risk Factors for Injury and Cigarette Smoking and Temporal Trends in Demographic and Lifestyle Characteristics among U.S. Army Ordnance School Students,* Technical Report No. 12-MA-083E-08. (Prepared by: Grier T, Knapik JJ, Canada S, Canham-Chervak M, and Jones BH.)

Soldiers who have completed Basic Combat Training (BCT) continue to Advanced Individual Training (AIT) where they learn their military occupational specialty. Previous studies of Ordnance students have focused on injuries experienced during AIT. This study examined risk factors for self-reported injury incurred before arrival for Ordnance AIT training from 2000–2006. Upon arrival for AIT, Soldiers (n=27,289 men and 3,856 women) completed a questionnaire that asked if they had a training-related injury that would interfere with their AIT training. The questionnaire also collected demographic and lifestyle characteristics. Backward stepping logistic regression was performed to examine associations between injury and other factors on the questionnaire. Multivariate odds ratios (OR) and 95 percent CI were calculated. The prevalence of training injuries on arrival for AIT was 7.6 percent for men and 17.4 percent for women. Temporal trends among U.S. Army Ordnance School Soldiers from 2000–2006 include an increase in older Soldiers, Caucasians, and fewer men smoking more than 20 cigarettes per day. The proportion of Ordnance AIT Soldiers 17-19 years old generally decreased, while the proportion of those 20-24, 25-29, and 30 plus years old increased. The proportion of male Caucasians progressively increased, from 58.2 percent in 2000 to 65.5 percent in 2006. The proportion of AIT Soldiers using cigarettes remained stable over the 7-year survey period. However, the amount of cigarettes men smoke appeared to decrease over time, with a smaller number of men reporting smoking 20 or more cigarettes per day. For both men and women, self-reported injury was associated with older age and a current self-reported illness. For men, analysis showed that higher risk of injury was independently associated with older age (OR (≥ 30years/17-19 years)=1.9, 95 percent CI=1.5-2.3), race (OR (Black/Caucasian)=1.2, 95 percent CI=1.1-1.4), BCT site (OR (Fort Benning/Fort Jackson)=1.7, 95 percent CI=1.4-2.1; OR (Fort Leonard Wood/Fort Jackson)=1.56, 95 percent CI=1.2-2.0), a current self-reported illness (OR (ill/not ill)=6.3, 95 percent CI=5.1-7.8) and smoking within the last 30 days before BCT (OR(smoking/not smoking)=1.2, 95 percent CI=1.1-1.3) (see Table 8). For women, increased risk of injury was independently associated with older age (OR (≥ 30years/17-19 years)=2.0, 95 percent CI=1.4-2.9), basic training site (OR (Fort Leonard Wood/Fort Jackson)=1.5, 95 percent CI=1.2-1.9), and a current self-reported illness (OR(ill/not ill)=5.8, 95 percent CI=3.9-8.7). Factors not independently associated with injury included rank and smokeless tobacco use. The risk factors identified in this study could be used to establish strategies to reduce injuries in BCT and tobacco use in the military.

Table 8. Risk Factors for Injury on Entry to Ordnance Advanced Individual Training: Multivariate Logistic Regression Results

Variable	Category	Men n	Men Odds Ratio (95%CI)	Men p-value	Women n	Women Odds Ratio (95%CI)	Women p-value
Age Group	17–19	11810	1.00	---	1960	1.00	---
	20–24	8921	1.25 (1.12–1.40)	<0.01	1085	1.30 (1.06–1.60)	0.01
	25–29	2236	1.68 (1.42–1.98)	<0.01	319	1.47 (1.08–2.00)	0.02
	≥ 30	1210	1.90 (1.54–2.34)	<0.01	163	1.99 (1.35–2.91)	<0.01
Race	Caucasian	15250	1.00	---	a		
	Black	3539	1.21 (1.05–1.40)	<0.01			
	Asian	723	0.83 (0.60–1.16)	0.28			
	Hispanic	3321	0.92 (0.78–1.07)	0.28			
	Native	659	1.25 (0.93–1.66)	0.14			
	Other	685	1.12 (0.83–1.50)	0.47			
Basic Training Site	Ft Jackson	7835	1.00	---	2943	1.00	---
	Ft Knox	12307	1.31 (1.16–1.47)	<0.01	22	0.96 (0.28–3.25)	0.94
	Ft Leonard Wood	941	1.55 (1.20–1.99)	<0.01	436	1.49 (1.16–1.92)	<0.01
	Ft Benning	1459	1.72 (1.40–2.11)	<0.01	b	b	b
	Ft Sill	1236	1.14 (0.88–1.46)	0.32	102	0.87 (0.50–1.53)	0.63
	Other	399	0.84 (0.54–1.29)	0.43	24	0.93 (0.31–2.81)	0.90
Illness	No	23743	1.00	---	3425	1.00	---
	Yes	434	6.32 (5.11–7.82)	<0.01	102	5.80 (3.87–8.67)	<0.01
Smoker	No	15211	1.00	---	c		
	Yes	8966	1.19 (1.07–1.32)	<0.01			

Legend:
[a] Did not reach the final step in the backwards stepping multivariate logistic regression.
[b] Women do not attend basic training at Ft Benning.
[c] Not retained in the model because it did not meet the p<.05 criteria in the univariate analysis.

(12) *Effects of Age and Smoking Prior to Basic Combat Training (BCT) on Initial Fitness Levels on Entry to BCT*. (Prepared by: Grier T, Knapik JJ, Swedler D, Hauret K, Williams K, Bullock S, Darakjy S, Lester M, Clemmons N, and Jones BH. Presented at the Annual Force Health Protection Conference, August 2008.)

Several studies suggest that smoking is associated with lower fitness in older (>40 years) smokers but not younger smokers. This study examined the fitness of male smokers and nonsmokers, aged <30 or ≥30 years old on entry to Basic Combat Training (BCT) (n=2262). Fitness and physical characteristics were obtained from unit records and age by questionnaire. Analysis of variance indicated that nonsmokers performed more push-ups (p<0.01), weighed more (p<0.01) and had a higher body mass index (BMI) (p<0.01), but 2-mile run times (p=0.11) and sit-up performance (p=0.17) were similar to smokers (Table 9). Younger men performed more sit-ups (p<0.01), were taller (p<0.01), weighed less (p<0.01), and had a lower BMI (p<0.01), but run times (p=0.32) and push-up performance (p=0.06) were similar to older men. Interactive effects of age and smoking were minimal. Fitness appeared to be influenced by smoking and age, but smokers did not show greater age-related decrements than nonsmokers. Although the interactive effects of smoking in the present study was minimal, cigarette smoking is a modifiable risk factor associated with a higher risk of musculoskeletal injury, skeletal muscle fatigue, and a compromised ability to repair damaged tissues. To decrease tobacco use in the Army, smoking cessation classes should be offered during BCT to prevent smoking initiation and enable previous smokers to remain tobacco-free once BCT is complete.

Table 9. Effects of Age and Smoking Prior to Basic Combat Training (BCT) on Initial Fitness Levels on Entry to BCT: A Summary of Findings

Variables	**Interaction of Age*Smoking** **(Age & Smoking of < 30 compared to ≥30)**	**Smoking** **(smokers compared to nonsmokers)**	**Age** **(Age < 30 compared to ≥ 30)**
2 Mile Run	Not significant (p=0.17)	Not significant (p=0.11)	Not significant (p=0.32)
Push-Ups	Not significant (p=0.22)	More among non-smokers (p<0.01)	More among Age<30 (p=0.06)
Sit-Ups	Not significant (p=0.20)	Not significant (p=0.17)	More among Age<30 (p<0.01)
BMI (Body Mass Index)	Not significant (p=0.59)	Higher among non-smokers (p<0.01)	Lower among Age<30 (p<0.01)

(13) *Prevention of Stress Fractures: Tested Interventions and Methodological Issues*. (Prepared by: Knapik JJ and Jones BH. Presented at the State of the Science Stress Fracture Research Conference, February 2008.)

Most investigations of stress fractures have focused on case studies, incidence, and risk factors, but few have tested various interventions to prevent stress fracture incidence. This presentation will review the literature and present new data on interventions designed to reduce stress fractures. A literature review was carried out using MEDLINE, the reference list from obtained articles, and contacts with investigators in the field. In addition, preliminary data was analyzed to determine if prescribing running shoes on the basis of the foot arch height could influence stress fractures in Army Basic Combat Training (BCT). There are several problems with the intervention studies that have been performed to date. All studies examined only a single variable (the intervention), and no studies performed a multivariate analysis controlling for other known risk factors. Stress fracture case definitions also varied. Many studies lacked statistical power because of small sample sizes and/or a small number of stress fractures. Studies have been limited in scope, examining only training adjustment, footwear modifications, and nutritional supplements. Despite these problems, several promising interventions have been identified and tested in basic training. Interventions that have been suggested in at least one study to reduce the incidence of stress fractures include reducing the amount of running, shock absorbent boots, orthotic boot inserts, and calcium with Vitamin D supplements. Several studies using multiple interventions in basic training suggest that stress fracture incidence can be reduced by combinations of reduced running/marching mileage, less marching in step, reduced marching speeds, more widely spaced formation, and having shorter individual lead formations. However, multiple intervention studies of these types do not allow identification of individual interventions that might have the largest injury reduction effect. Interventions that appear to have no effect on stress fracture incidence include shock absorbent insoles (Sorbothane®, urethane, and Neoprene®), cessation of running for one week of BCT, leather verses tropical combat boots, and prescribing running shoes on the basis of the height of foot arch. While several interventions appear promising, most studies have methodological problems and most promising interventions have only been tested in a single study. Interventions that have been suggested to reduce stress fractures incidence should be verified in future studies with larger sample sizes and appropriate control of known risk factors. (Sorbothane® is a registered trademark of Sorbothane, Inc.; Neoprene is a registered trademark of DuPont Corporation.)

(14) *Associations between Physical Fitness and Stress Fracture Incidence.* (Prepared by: Knapik JJ, Canada S, and Jones BH. Presented at the State of the Science Stress Fracture Research Conference, February 2008.)

A number of studies have now examined associations between physical fitness and risk of stress fractures in military and civilian populations. The aim of this investigation was to conduct a literature review and present new data on the association between stress fractures and the various components of physical fitness. The review had two purposes: (1) to define physical fitness and (2) to examine studies that had investigated associations between physical fitness and stress fractures. A literature review was carried out using MEDLINE, the reference list from obtained articles, and contacts with investigators in the field. In addition, combined data from seven Army Basic Combat Training (BCT) studies conducted between 1998 and 2000 at Fort Jackson, South Carolina were analyzed to further examine associations between fitness and stress fractures. Fitness has been defined as a set of attributes that allow the performance of physical activity. The attributes or components of physical activity were initially identified using factor analysis. These fitness components have been shown to be related to phenomenon in three spheres: mechanical (contractile force, power, contractions to fatigue), physiological (muscle fiber type), and metabolic (oxygen requirement and energy substrates). The fitness components which have been examined in relation to stress fractures include aerobic capacity, muscle strength, muscle endurance, and flexibility. Measures of aerobic fitness have almost exclusively involved maximal effort runs at distances ranging from 0.75 to 2 miles (1.2 to 3.2 kilometers). These studies and the analysis of the seven studies from Fort Jackson generally showed that individuals in the lowest quartile of run performance are 2 to 4 times more likely to suffer a stress fracture than those in the highest quartile of run performance. There were only three studies found examining muscle strength: one found that greater leg press strength was associated with lower stress fracture incidence; but two other studies found that prospectively measured isometric knee extension strength did not differ between stress fracture and non-stress fracture cases. Several studies, including the analysis of stress fractures during the seven BCT cycles at Fort Jackson, suggested that lower muscular endurance was associated with higher stress fracture incidence; however, there was also data showing no association. Finally, studies involving a wide variety of lower body flexibility measures showed that these were not associated with stress fracture incidence. The association between aerobic fitness and stress fractures could be due to a number of hypothetical mechanisms: (1) the possibility that aerobic fitness as measured by run performance may be a marker for weight-bearing physical activity, (2) those with higher aerobic fitness may have more effective bone remodeling, and (3) those with low aerobic fitness fatigue more rapidly during prolonged physical activity and this may put unaccustomed stress on bones and joints. Low aerobic fitness is associated with a higher incidence of stress fractures. It is not clear whether muscular strength or muscular endurance is associated with stress fractures. Measures of flexibility do not appear to be associated with stress fractures. Additional examinations of associations between muscle strength, muscular endurance, and stress fractures are needed. To further explore the relationship between aerobic fitness and stress fractures, more sensitive measures of pre-training physical activity and physical activity during BCT are required as well as markers of bone remodeling.

(15) *Influence of Iron Supplementation on Injury Risk in Basic Combat Training*, Technical Report No. 12MA0896-08. (Prepared by: Knapik JJ, Spiess A, McClung J, Corum S, Williams K, Nindl B, Lieberman H, and Tobler S.)

In a double-blinded study design, female Army basic trainees were randomized into either an iron supplement group (ISG, n=105) or a placebo group (PG, n=103). The ISG consumed 16 milligrams elemental iron daily. Prior to treatment, measures of physical activity, tobacco use, menstrual status, physical characteristics, body composition, physical fitness, and demographics were obtained. Blood was collected to identify subjects who were iron deficient (ID) or had iron deficiency anemia (IDA). Injury outcomes were obtained from outpatient medical surveillance data. Risk ratios (RR) and 95 percent CIs were calculated. Cox regression indicated little difference in injury risk between the ISG and PG in multivariate analysis that included significant injury covariates (RR (ISG/PG)=1.14, 95 percent CI=0.79-1.64, p=0.48). For ID subjects (n=34), univariate Cox regression showed little difference in injury risk between the ISG and PG (RR (ISG/PG)=0.85, 95 percent CI=0.41-2.10, p=0.85). For IDA subjects (n=43), Cox regression also showed little difference in injury risk between the ISG and PG in multivariate analysis that included significant injury covariates (RR (ISG/PG)=0.87, 95 percent CI=0.36-2.07, p=0.75). Statistical power analysis indicated that sample sizes of 1,130 ID subjects and 1,680 IDA subjects (in each group) would be needed before these group differences (ISG vs. PG) were statistically significant at the p=0.05 level (power=80 percent). Thus, this study lacked the statistical power to determine conclusively that iron supplementation reduces injuries in BCT. Further investigation with a larger sample size is needed to make recommendations on iron supplementation as an injury prevention strategy in BCT.

(16) *Injury Reduction Effectiveness of Prescribing Running Shoes based on Foot Shape in Basic Combat Training,* Technical Report No. 12-MA-05SB-08. (Prepared by: Knapik JJ, Swedler D, Grier T, Hauret K, Williams K, Bullock S, Darakjy S, Lester M, Clemmons N, Brown J, and Jones BH.)

In Basic Combat Training (BCT), running shoes are prescribed based on plantar foot shape (reflecting longitudinal arch height). In response to a request from the Military Training Task Force of the Defense Safety Oversight Council, this study examined whether or not this prescription technique influenced injury risk. After foot examinations, BCT recruits in an experimental group (E, n=1,079 men, 456 women) were prescribed motion control, stability, or cushioned shoes for foot shapes judged to represent low, medium, or high arches, respectively. A control group (C, n=1,068 men, 464 women) received a stability shoe regardless of plantar foot shape. Injuries during BCT were determined from outpatient visits provided by the Army Medical Surveillance Activity (now the Armed Forces Health Surveillance Center). Other previously known injury risk factors (e.g., age, fitness, smoking) were obtained from a questionnaire and existing databases. Multivariate Cox regression controlling for other injury risk factors showed little difference between the E and C groups among men (hazard ratio (E/C) = 1.11, 95 percent CI = 0.91–1.34) or women (hazard ratio (E/C)=1.14, 95 percent CI = 0.91–1.44) (Table 10). Those with complete data on all variables included 1,239 men (58 percent of the entire male sample) and 461 women (50 percent of the female sample). This prospective study demonstrated that prescribing shoes on the basis of the shape of the plantar foot surface had little influence on injury risk in BCT even after control of known injury risk factors.

Table 10. Injury Risk by Variable for Prescribed Running Shoes Subjects, Army Basic Combat Training: Multivariate Cox Regression Results by Gender

Variable	**Level of Variable**	**n**	**Hazard Ratio (95%CI)**	**p-value**
Men				
Group	C	623	1.00	---
	E	616	1.11 (0.91–1.34)	0.31
2-Mile Run	11.7–16.0 minutes	310	1.00	---
	16.1–17.4 minutes	315	1.08 (0.81–1.43)	0.62
	17.5–20.2 minutes	305	1.22 (0.92–1.62)	0.18
	20.3–32.2 minutes	309	1.47 (1.11–1.95)	<0.01
Physical Activity Before BCT	Much Less Active	109	1.65 (1.05–2.62)	0.03
	Somewhat Less Active	292	1.02 (0.67–1.55)	0.94
	About the Same	414	0.99 (0.66–1.49)	0.96
	Somewhat more Active	334	0.93 (0.62–1.41)	0.73
	Much More Active	90	1.00	---
How Old First Time Smoked Whole Cigarette	Never	414	1.00	---
	6–9 years	30	2.63 (1.57–4.43)	<0.01
	10–14 years	252	1.99 (1.53–2.58)	<0.01
	15–19 years	479	1.27 (1.00–1.62)	0.05
	≥ 20 years	64	1.02 (0.61–1.69)	0.96
Women				
Group	C	242	1.00	---
	E	219	1.14 (0.91–1.44)	0.26
2-Mile Run	12.3–19.4 minutes	117	1.00	---
	19.5–22.1 minutes	114	0.89 (0.64–1.26)	0.52
	22.2–24.7 minutes	115	1.10 (0.79–1.53)	0.57
	24.8–31.3 minutes	115	2.13 (1.55–2.91)	<0.01

Table 10. Injury Risk by Variable for Prescribed Running Shoes Subjects, Army Basic Combat Training: Multivariate Cox Regression Results by Gender (continued)

Variable	Level of Variable	n	Hazard Ratio (95%CI)	p-value
Women				
Smoking in Last 30 Days	None	266	1.00	---
	1–9 days	47	1.36 (0.93–2.00)	0.12
	10–19 days	23	1.70 (1.05–2.75)	0.03
	≥ 20 days	125	1.52 (1.16–1.99)	<0.01
Quit Smoking	Seldom/Never	275	1.00	---
	Smoker	125	[a]	[a]
	1–12 months	40	1.83 (1.25–2.67)	<0.01
	> 12 months	21	1.05 (059–1.87)	0.87
Marital Status	Single	328	1.00	---
	Married	107	1.29 (0.99–1.69)	0.06
	Other	26	1.68 (1.05–2.71)	0.03
Lower Limb Injury	No	393	1.00	---
	Yes	68	1.57 (1.16–2.13)	<0.01

Legend:
[a] Linearly codependent with ≥ 20 days in ―Smoking in Last 30 days" variable (same subjects)

(17) *Injury Reduction Effectiveness of Prescribing Running Shoes based on Foot Shape in Air Force Basic Military Training*, Technical Report No. 12-MA-05SBA-08A. (Prepared by: Knapik JJ, Brosch LC, Venuto M, Swedler DI, Bullock SH, Gaines LS, Murphy RJ, Canada SE, Hoedebecke EL, Tobler SK, Tchadja J, and Jones BH.)

In response to a request from the Military Training Task Force of the Defense Safety Oversight Council, this study examined whether prescribing running shoes based on the shape of the plantar surface influenced injury risk in Air Force Basic Military Training (BMT). After foot examinations, BMT recruits in an experimental group (E, n=1,042 men, 375 women) were prescribed motion control, stability, or cushioned shoes for plantar shapes indicative of low, medium, or high arches, respectively. A control group (C, n=913 men, 346 women) received a stability shoe regardless of plantar shape. Injuries during BMT were determined from outpatient visits provided by the Army Medical Surveillance Activity (now the Armed Forces Health Surveillance Center). Other known injury risk factors (e.g., fitness, smoking) were obtained from a questionnaire, existing databases, or BMT units. Multivariate Cox regression controlling for other risk factors showed little difference between the E and C groups among men (hazard ratio(E/C)=1.11, 95 percent CI=0.89–1.38) or women (hazard ratio(E/C)=1.14, 95 percent CI = 0.85–1.55) (Table 11). Those with complete data on all variables included 1,268 men (65 percent of the entire male sample) and 365 women (51 percent of the female sample). This prospective study demonstrated that prescribing shoes on the basis of the shape of the plantar foot surface had little influence on injury risk in BMT even when controlling for other injury risk factors.

Table 11. Injury Risk by Variable for Prescribed Running Shoes Subjects, Air Force Basic Military Training: Multivariate Cox Regression by Gender Results

Variable	Level of Variable	n	Hazard Ratio (95% CI)	p-value
Men				
Group	E C	658 610	1.11 (0.89-1.38) 1.00	0.35 ---
1.5-Mile Run	8.33-11.53 minutes 11.54-12.63 minutes 12.64-13.97 minutes 13.98-20.53 minutes	330 305 310 323	1.00 0.92 (0.66-1.29) 1.33 (0.97-1.80) 1.42 (1.05-1.93)	--- 0.64 0.07 0.02
Q10. Smoked Cigarettes in Last 30 Days	No Yes	929 339	1.00 1.28(1.01-1.61)	--- 0.04
Women				
Group	E C	187 178	1.14 (0.85-1.55) 1.00	0.38 ---
1.5-Mile Run	9.67-14.92 minutes 14.93-16.50 minutes 16.51-18.23 minutes 18.24-31.40 minutes	103 98 83 81	1.00 1.16 (0.75-1.80) 1.11 (0.70-1.75) 1.95 (1.24-3.05)	--- 0.51 0.66 <0.01
Q10. Smoked Cigarettes in Last 30 Days	No Yes	297 68	1.00 1.39 (0.95-2.05)	--- 0.10
Q16. Length of Time Running/Jogging Before BMT	≤1 month 2-6 months ≥7 months	147 179 39	1.21 (0.62-2.34) 1.74 (0.94-3.22) 1.00	0.58 0.08 ---
Marital Status[a]	Single Married	310 55	1.00 1.53 (1.04-2.27)	--- 0.03
Bony Arch Index, Left	Low (lower 20%) Normal (middle 60%) High (highest 20%)	69 219 77	1.80 (1.25-2.58) 1.00 0.91 (0.61-1.35)	<.01 --- 0.63

Legend:
[a] None of the ―other" marital status women were included in this analysis because only 2 subjects in this category had complete data on other variables.

(18) *Risk Factors for Parachute Injuries and Airborne Student Observations on the Parachute Ankle Brace,* Technical Report No. 12-MA01Q2-08B. (Prepared by: Knapik JJ, Spiess A, Darakjy S, Grier T, Manning F, Swedler D, Amoroso P, and Jones BH.)

A questionnaire was administered to 1,956 students in Army Airborne training as part of an effort by the Military Training Task Force of the Defense Safety Oversight Council to evaluate the parachute ankle brace (PAB). Information provided by the questionnaire identified potential injury risk factors and comments on the PAB. Independent risk factors for injuries in the past year among males (All Services) included Airborne recycling, less physical activity, older age, and higher body mass index (Table 12). The sample size for the women was very small and, as a result, the associations were weak. However, less physical activity was associated with an injury in the past year among women. Independent risk factors for jump week injuries among male Airborne trainees (All Services) included older age, Airborne recycling, height, higher body weight, not wearing the PAB, aircraft exit problems, and injury in the past year (Table 13). Students who had worn the brace were more likely to have favorable comments on the PAB compared with those who had not worn it. Most negative PAB comments were related to the heel strap, and an improvement has been proposed and is in production. Students complained that the PAB rubbed on the legs, shin, ankle, and calf; this might be associated with the heel strap or pulling the ankle strap too tight; this problem might be alleviated by the strap improvement and/or better guidance on appropriate tightness for the ankle straps. Students also complained of difficulty in keeping the feet and knees together when wearing the PAB. This could be a matter of perception or some adaptation and accommodation may be required in this area. The bottom line is that the PAB prevents ankle injuries during airborne training (with the T-10 parachute).

Table 12. Independent Risk Factors Associated with Self-Reported Injury in the Last Year, All Service Men: Multivariate Logistic Regression Results

Variable	Level of Variable	N	Odds Ratio (95% Confidence Interval)	p-value
Age	17–19 yrs	383	1.00	---
	20–24 yrs	1046	1.19 (0.82–1.72)	0.35
	25–29 yrs	241	1.15 (0.70–1.89)	0.59
	≥30 yrs	114	2.29 (1.31–3.97)	<0.01
Airborne Recycle	No	1636	1.00	---
	Yes	148	1.76(1.15–2.71)	<0.01
Body Mass Index	17.35–22.97 kg/m^2	431	1.00	---
	22.98–24.40 kg/m^2	415	0.88 (0.57–1.34)	0.54
	24.41–25.86 kg/m^2	491	1.01 (0.68–1.50)	0.97
	25.87–40.79 kg/m^2	447	1.54 (1.05–2.27)	0.03
Physical Activity	Much More Active	598	1.00	---
	Somewhat More Active	763	0.89 (0.64–1.24)	0.50
	About the Same	388	1.47 (1.03–2.11)	0.03
	Somewhat Less Active	30	1.59 (0.62–4.06)	0.34
	Much Less Active	5	2.04 (0.22–18.70)	0.53

Table 13. Independent Risk Factors Associated with Self-Reported Jump-Week Injuries, All Service Men: Multivariate Logistic Regression Results

Variable	Level of Variable	N	Odds Ratio (95% Confidence Interval)	p-value
Age	17–19 yrs	330	1.00	---
	20–24 yrs	1035	1.13 (0.60–2.14)	0.70
	25–29 yrs	239	1.31 (0.58–2.92)	0.52
	≥30 yrs	113	3.34 (1.49–7.47)	<0.01
Weight	105–159 lbs	419	1.00	---
	160–170 lbs	483	2.11 (1.01–4.43)	0.05
	171–184 lbs	363	1.38 (0.61–3.15)	0.44
	185–285 lbs	502	2.45 (1.2–5.04)	0.01
Airborne Recycle	No	1620	1.00	---
	Yes	147	2.25 (1.20–4.23)	0.01
Parachute Ankle Brace	No	979	1.68 (1.07-2.65)	0.03
	Yes	788	1.00	---

Table 13. Independent Risk Factors Associated with Self-Reported Jump-Week Injuries, All Service Men: Multivariate Logistic Regression Results (continued)

Variable	Level of Variable	N	Odds Ratio (95% Confidence Interval)	p-value
Aircraft Exit Problem	No Yes	1721 46	1.00 4.18 (1.70–10.26)	--- <0.01
Injury in Past Year	No Yes	521 246	1.00 3.48 (2.15–5.63)	--- <0.01

(19) *A Survey of Parachute Ankle Braces Breakages,* Technical Report No. 12-MA01Q2A-08B. (Prepared by: Knapik JJ, Darakjy S, Grier T, Spiess A, Manning F, Livingstone E, Amoroso P, and Jones BH.)

The parachute ankle brace (PAB) has been shown to reduce the incidence of ankle injuries, while not complicating parachute entanglements or increasing injuries in other parts of the body. On the other hand, PABs have a limited lifespan. A survey was conducted to identify areas of the PAB most susceptible to breakage. A total of 1,668 individual ankle braces judged nonfunctional by the U.S. Army Airborne School were analyzed. Plastic shells, ankle straps, and heel straps accounted for 14 percent, 27 percent, and 59 percent of the breakages, respectively (Table 14). The areas with the greatest number of breakages were (in order of frequency): (1) the Velcro® portion of the heel strap, (2) the center of the heel strap, (3) the rivet/screw at the Velcro end of the heel strap, and 4) the back of the plastic shell. These four types of breakages collectively accounted for 64 percent of all the breakages. Of the multiple breakage events, 89 percent involved the heel strap. These data indicate that the majority of breakages occurred to the heel strap. The reason for heel strap breakages is most likely the change in the military boot. The PAB was originally designed for the older black combat boot. When the PAB was placed on the newest desert boot, the heel strap could slip over the curved part of the heel causing the PAB to move backwards; the heel strap could be stepped upon and abraded. Improvements have been proposed by the brace manufacturer in consultation with the U.S. Army Airborne School to add a stabilizing strap over the dorsum of the foot. There was also a suggestion in the data that recent improvements in the composition of the plastic shell have improved resistance to breakage. (Velcro® is a registered trademark of Velcro Industries B.V.)

Table 14. Parachute Ankle Brace Breakages by Location

Brace Area	General Breakage Location	Specific Breakage Location	Events[a] (n)	Proportion of Total Breakages (%)
Plastic Shell (n=270)		Back	225	11.6
		Side	43	2.2
		Both Sides	1	0.1
		Side and Back	1	0.1
Ankle Strap (n=532)	Strap Torn Near Rivet (n=83)	Top Strap	18	0.9
		Bottom Strap	60	3.1
		Both Straps	5	0.3
	Strap Torn Near Middle (n=29)	Top Strap	17	0.9
		Bottom Strap	9	0.5
		Both Straps	3	0.2
	Strap Torn Near Velcro Hooks (n=242)	Top Strap	83	4.3
		Bottom Strap	100	5.2
		Both Straps	59	3.0
	Broken Buckle (n=178)	Top Buckle	19	1.0
		Bottom Buckle	146	7.5
		Both Buckles	13	0.7
Heel Strap (n=1137)		Center	338	17.4
		Velcro	435	22.4
		Rivet/Screw (Buckle End)	4	0.2
		Rivet/Screw (Velcro End)	308	15.9
		Bent Buckle	51	2.6
		Missing Buckle	1	0.1

Legend:
[a] Note that when both ankle straps are broken this is actually two breakage events but they are listed as a single breakage in this table.

(6) The Injury Prevention Program produced a number of nondeployment-related analyses, field investigations, and program evaluations in 2008. The citations are listed below—

(a) 2008 Technical Reports

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7. CONCLUSIONS

a. Army Injury Surveillance Summary 2008. This section summarizes available medical surveillance data affecting Active Duty, nondeployed U.S. Army Soldiers. Key findings indicated–

(1) For every 1 injury-related death, there were 18 hospitalizations and 1,655 outpatient visits in 2008.

(2) Injury was the leading cause of medical encounters (909,989 medical encounters in 2008), affecting over 250,000 Soldiers.

(3) Among Army Soldiers, injury visit rates increased 28.6 percent from 2005 to 2008, while rates among Army trainees from 2003 to 2008 declined by 37.8 percent.

(4) Injury was one of the leading causes of hospitalization among Army Soldiers (5,871 hospitalizations in 2008), exceeded only by mental disorders. Injury and injury-related musculoskeletal conditions resulted in more outpatient visits (546,032 outpatient visits in 2008) than any other medical condition.

(5) The most frequently reported causes of accidental injuries that required hospitalization were falls or near-falls (e.g. slips, trips) (18.4 percent), land transport accidents (18.4 percent), and athletics/sports (9.3 percent).

(6) The most common, specific-injury types leading to hospital admission were fractures (37.3 percent), internal injuries (12.6 percent) and sprains/strains (9.3 percent). Injury hospitalizations were most likely to involve the upper (18.0 percent) or lower (26.9 percent) extremities.

(7) Injury-related outpatient visits were most commonly the result of sprains and/or strains (51.0 percent), contusions/superficial wounds (16.7 percent), and fractures (9.5 percent), particularly sprains and strains to the lower leg, ankle, shoulder and upper arm.

(8) The most common types of injury-related musculoskeletal conditions leading to hospital admission were joint derangement (45.3 percent), inflammation and pain associated with overuse (28.1 percent), and sprains/strains/ruptures (13.3 percent).

The greatest proportion of hospitalizations involved the spine and back (41.6 percent), followed by lower extremities (34.6 percent).

(9) Most injury-related, musculoskeletal conditions treated on an outpatient basis were due to inflammation and pain associated with overuse (85.5 percent), followed by joint derangement (7.7 percent) and joint derangement with neurological involvement (3.1 percent). Over 75 percent of outpatient visits for injury-related musculoskeletal conditions
affected two body regions—the spine/back (33.1 percent) and lower extremities (45.1 percent).

b. Army Injury Epidemiology Project Summaries 2008: Analyses, Investigations, and Evaluations. Conclusions from the USAPHC (Prov) Injury Prevention Program nondeployment related injury investigations completed in 2008 were as follows:

(1) *Setting Priorities in Preventive Medicine*. A prioritized list of the U.S. Army's top ten injury issues (currently used to direct USAPHC (Prov) injury prevention efforts) was generated utilizing a systematic, evidence-based process. Using data, predetermined criteria, and an objective rating process, the top Army injury prevention priorities were determined to be physical training, privately owned motor vehicle accidents, athletic/sports, excessive heat, military motor vehicle accidents, falls/jumps, marching/drilling, lifting/pushing/pulling, military air transport accidents, and excessive cold.

(2) *Establishing Evidence-Based Injury Prevention Priorities: An Example Process.* Three ranking procedures (mean scores, harmonic mean scores, and weighted, normalized mean scores) resulted in the same top two injury issues: physical training injuries and motor vehicle accidents. The following causes of injury also appeared in the top ten, regardless of ranking procedure (listed in rank order by mean scores): physical training, privately owned vehicle accidents, athletics/sports, excessive heat, military motor vehicle accidents, falls/jumps, marching/drilling, lifting/pushing/pulling, military air transport accidents, and excessive cold.

(3) *The Five Essential Elements of the Public Health Process/Practice.* The five elements of the public health process, necessary to make continued progress toward prevention of disease and injury are: (1) surveillance, (2) research and field investigation, (3) intervention trials, (4) program and policy implementation, and (5) evaluation of strategies, programs, and policies.

(4) *Putting the Public Health Process into Practice: Examples of Public Health Program and Policy Evaluations.* Effective program evaluations resulted in

modifications to physical training and reintroduction of parachute ankle braces in Army airborne training.

(5) *Approaches to Injury Surveillance at the Local Level.* Surveillance systems at the Armed Forces Health Surveillance Center and the U.S. Army Public Health Command (Provisional) can be utilized by preventive medicine and public health personnel to identify injury occurrences and to be alerted of emerging injury problems.

(6) *Department of Defense Injury Burden: A Summary of Medical Surveillance Data.* Medical surveillance data provide a means of tracking injury rates, establishing leading causes, and providing information needed to prioritize Department of Defense injury prevention efforts.

(7) *Injury-Related Musculoskeletal Conditions: An Under-Recognized Injury Problem among Military Personnel.* When injury-related musculoskeletal conditions are combined with acute traumatic injuries, there are almost 1.6 million injury-related medical encounters in the military Services each year, an almost 50 percent increase in the number of annual clinical encounters for injuries. The additional injury encounters are largely for conditions such as stress fractures and Achilles tendonitis; conditions that are well recognized as injuries in the sports medicine community. The injury-related musculoskeletal condition matrix is an epidemiologic tool that provides a standardized format to categorize these injuries, make comparisons over time, identify leading injury types and/or body regions upon which prevention efforts can focus.

(8) *Oral-Maxillofacial Injuries among Active Duty U.S. Military Personnel, 1996–2005*. The oral-maxillofacial fracture rates for men were consistently 1.5 to 2 times higher than those for women. Unlike fractures, wound rates for men and women were similar over time. Active Duty personnel under age 25 had the highest rates of both oral-maxillofacial fractures and wounds. Fighting (13.5 percent) and land-transport accidents (8.4 percent) were the leading causes of oral-maxillofacial injury hospitalizations in 2005, followed by war-related incidents (8 percent), gun/explosives training and handling (8 percent), and falls (5.1 percent).

(9) *The Epidemiology of Falls, Slips, and Trips in the U.S. Army.* Analysis of medical surveillance and administrative data has demonstrated that slips, trips, and falls account for 16-18 percent of Army injury hospitalizations annually. Such injuries, whether suffered at home or overseas, result in unnecessary costs including medical expenses, lost work time, and manpower reductions.

(10) *The Association of Health Risk Behaviors, Risk-Taking, and Injuries during Army Basic Combat Training*. Among males, risk-taking and cigarette use were associated with training-related injury while controlling for known risk factors. Among females, injury risk was associated with individual health risk behaviors related to

cigarette use and diet/lifestyle choices. These data suggest that training-related injury risk, particularly among male Soldiers, is influenced by risk taking-tendency, a potentially modifiable risk factor.

(11) *Risk Factors for Injury and Cigarette Smoking and Temporal Trends in Demographic and Lifestyle Characteristics among U.S. Army Ordnance School Students.* Temporal trends among U.S. Army Ordnance School Service Members from 2000–2006 included an increase in older Service Members, Caucasians, and fewer men smoking more than 20 cigarettes per day. For both men and women, self-reported injury was associated with older age and a current self-reported illness. The likelihood of smoking on 20 or more days prior to basic combat training (BCT) was associated with older age, Caucasian race, and smokeless tobacco use.

(12) *Effects of Age and Smoking Prior to Basic Combat Training (BCT) on Initial Fitness Levels on Entry to BCT*. Physical fitness appears to be negatively influenced by smoking and age in this population of Army basic trainees, but those who smoked prior to Basic Combat Training did not show greater age-related decrements in fitness than nonsmokers.

(13) *Prevention of Stress Fractures: Tested Interventions and Methodological Issues*. While several interventions appear promising, most studies have methodological problems and most promising interventions have only been tested in a single study, so clear recommendations to prevent stress fractures cannot be made at this time.

(14) *Associations between Physical Fitness and Stress Fracture Incidence.* Low aerobic fitness is associated with a higher incidence of stress fractures. It is not clear whether muscular strength or muscular endurance is associated with stress fractures. Measures of flexibility do not appear to be associated with stress fractures.

(15) *Influence of Iron Supplementation on Injury Risk in Basic Combat Training*. This study lacked the statistical power to determine conclusively that iron supplementation reduces injuries in Army Basic Combat Training.

(16) *Injury Reduction Effectiveness of Prescribing Running Shoes based on Foot Shape in Basic Combat Training*. This prospective study demonstrated that prescribing shoes on the basis of the shape of the plantar foot surface had little influence on injury risk in Army Basic Combat Training even after control of known injury risk factors.

(17) *Injury Reduction Effectiveness of Prescribing Running Shoes based on Foot Shape in Air Force Basic Military Training.* This prospective study demonstrated that prescribing shoes on the basis of the shape of the plantar foot surface had little

influence on injury risk in Air Force Basic Military Training even after control of other injury risk factors.

(18) *Risk Factors for Parachute Injuries and Airborne Student Observations on the Parachute Ankle Brace.* Among male students of all Services attending the U.S. Army Airborne School, independent risk factors for injuries in the past year included Airborne recycling, less physical activity, older age, and higher body mass index. Risk factors independently associated with jump-week injuries included older age, Airborne recycling, higher body weight, not wearing the parachute ankle braces (PAB), aircraft exit problems, and injury in the past year. Students who had worn the PAB had more favorable attitudes toward the PAB than those who had not worn it. Most negative PAB comments were related to the heel strap. An improvement has been proposed and is in production. Students complained that the PAB rubbed on the legs, shin, ankle, and calf; this might be alleviated by improvements in the heel strap and/or better guidance on appropriate tightness for the ankle straps. Students complained of difficulty in keeping the feet and knees together when wearing the PAB. This may just be a matter of perception, and/or some adaptation and accommodation may be required in this area. The bottom line is that the PAB prevents ankle injuries during airborne training (with the T-10 parachute).

(19) *A Survey of Parachute Ankle Braces Breakages.* The major breakage location on the parachute ankle braces (PAB) was the heel strap. On the heel strap, the Velcro®, the center of the strap, and the rivet on the Velcro end were the specific areas subject to the greatest number of breakage events. A proposed modification has been developed by DJO Incorporated in consultation with the U.S. Army Airborne School to more effectively hold the brace on the boot and reduce heel strap breakages. This modification adds a strap over the dorsum of the foot. The ankle strap at the Velcro attachment was also found to have a high level of breakage, and strengthening the attachment of the Velcro hooks to the strap may decrease the breakage incidence in this area. The modification of the plastic shell in the third generation PAB may result in less shell breakage, as well. (Velcro® is a registered trademark of Velcro Industries B.V.)

8. RECOMMENDATIONS

a. Recommendations Resulting from Army Injury Surveillance 2008.

(1) Given the magnitude of the injury problem in the Army as demonstrated by these data, resources should be directed toward injury prevention and research activities.

(2) To most effectively and efficiently address Army injuries, a data-driven prioritization process is recommended to focus resources on the most preventable of the leading Army injury problems.

(a) The process should include the analysis of nonfatal medical surveillance data, as presented in this report, given that the bulk of the Army injury burden is nonfatal injuries.

(b) When formulating prevention priorities, factors that should be considered include the frequency, incidence, and severity of injuries; resulting costs; size of the population at risk; preventability of the problem; feasibility of establishing prevention programs or policies; and the ability to evaluate the effect of implemented programs and policies.

(c) When formulating research priorities, factors similar to those used to prioritize prevention should be considered. These should include not only the frequency, incidence, and severity of injuries; resulting costs; and size of the population at risk; but also, existence of gaps in knowledge of prevention; military uniqueness; potential value of the research; and feasibility of the research.

(3) Results of this analysis should be used to inform injury prevention and research priorities.

(a) Falls/near-falls, transport accidents, and sport-related injuries should be a focus for prevention and research activities for the Army.

(b) Fractures, sprains, and strains, and overuse injuries of the back and lower extremities represent the types of injury to focus prevention and research activities for the Army.

(4) Data in this report should also be combined with future injury surveillance analyses to identify trends in injury rates and causes over time.

b. Recommendations Resulting from Army Injury Epidemiology Projects 2008.

(1) Prevention Planning Recommendations

(a) The USAPHC (Prov) criteria for prioritizing programs and policies should be used to systematically assess and prioritize injury and disease prevention initiatives in the U.S. military. The process of establishing evidenced-based prevention priorities reduces subjectivity and conflicts of interest in setting priorities and could be adapted for use in safety and public health prevention planning in the Army and other populations.

Prevention resources can be allocated more efficiently and effectively using objective criteria to identify the biggest, most preventable problems.

(b) Public health and preventive medicine programs should engage in each of the five steps of the public health process, in order to effectively prevent or mitigate injuries in the U.S. military. Implemented policies, programs, and interventions should be evaluated for effectiveness as part of the public health process. The USAPHC (Prov) Injury Prevention Program is a potential resource for installation preventive medicine personnel to assist with executing various aspects of the public health process.

(2) Injury Surveillance Recommendations

(a) Available medical surveillance data should be utilized to track injury rates, establish leading causes, and provide information needed to prioritize Army injury prevention efforts. Preventive medicine and public health personnel at local military treatment facilities should routinely access surveillance systems and other resources to identify emerging injury issues and prioritize their efforts in addressing current injury issues.

(b) When assessing the magnitude of the injury problem in the military Services, injury-related musculoskeletal conditions, such as stress fractures, Achilles tendonitis, and plantar fasciitis, should be included.

(c) The military would benefit from a system of surveillance that incorporates not only medical care data, but also dental care data.

(3) Injury Research and Field Investigations Recommendations

(a) Because of the magnitude and severity of the problem with falls in the U.S. Army, additional research on risk factors, causes, and interventions to prevent falls among working-age populations is needed.

(b) Intervening on potentially modifiable risk factors for training-related injury, such as smoking, should be explored to reduce the risk of training-related injuries. To decrease tobacco use in the Army, smoking cessation classes should be offered during Basic Combat Training to prevent smoking initiation and enable previous smokers to remain tobacco-free beyond Basic Combat Training.

(c) The effectiveness of interventions to reduce stress fractures should be verified in future studies with larger sample sizes and appropriate control of known risk factors. Promising interventions that have been suggested include reducing the amount of running, wearing shock absorbent boots, using orthotic boot inserts, and taking calcium with Vitamin D supplements. Additional examinations of associations between muscle strength, muscular endurance, and stress fractures are also needed. To further explore the relationship between aerobic fitness and stress fractures, more sensitive measures of pre-training physical activity and physical activity during Basic Combat Training are required, as well as markers of bone remodeling.

(d) Quality intervention studies on the strategies to prevent oral and craniofacial injury is needed. Prevention of fighting and motor vehicle crash-related oral-maxillofacial injuries should also be examined as a strategy for reducing military oral-facial injuries.

(4) Injury Policy and Program Evaluation Recommendations

(a) Further investigation with a larger sample size is needed to make recommendations on iron supplementation as an injury prevention strategy in Army Basic Combat Training.

(b) Prescribing running shoes on the basis of plantar shape as a strategy to reduce injuries in U.S. military training is ineffective.

(c) Prior to airborne training, students should improve their aerobic capacity and upper body muscular endurance to prevent injuries. Leaders should also instruct students on use of the parachute ankle brace (PAB) and assure they wear the PAB during training jumps. A proposed modification has been developed by a manufacturer in consultation with the U.S. Army Airborne School to more effectively hold the brace on the boot and reduce heel strap breakages.

9. POINT OF CONTACT. The point of contact at USAPHC (Prov) Injury Prevention Program is Ms. Esther Laseinde, commercial (410) 436-9290/3534, or DSN 584-9290/3534. Ms. Laseinde may also be reached by electronic mail at esther.laseinde@us.army.mil. For additional injury-related information and resources, visit the USAPHC (Prov) Injury Prevention Program Web site at http://chppm-www.apgea.army.mil/DEDS-Injury.

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APPENDIX A

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APPENDIX B
INJURY DIAGNOSIS CODES (ICD 9-CM CODES†) BY ANATOMICAL REGION

Head and neck

363.61 363.63 364.04 364.41 364.76 364.77 365.65 366.20 379.32 379.33 379.34 525.11 722.0 722.71 723.1 723.4 800 801 802 803 804 805.0 805.1 806.0 806.1 807.5 807.6 830 839.0 839.1 847.0 848.0 848.1 848.2 850 851 852 853 854 870 871 872 873 874 900 910.0 910.1 910.2 910.3 910.6 910.7 910.8 910.9 918 920 921 925 930 931 932 933 935.0 940 941 947.0 950 951 952.0 953.0 954.0 957.0 959.0

Shoulder and arm

354.1 354.2 354.3 716.11 716.12 716.13 718.01 718.02 718.03 718.11 718.12 718.13 718.31 718.32 718.33 718.81 718.82 718.83 718.91 718.92 718.93 719.01 719.02 719.03 719.11 719.12 719.13 719.41 719.42 719.43 726.0 726.1 726.2 726.3 727.61 727.62 733.11 810 811 812 813 818 831 832 840 841 880 881.00 881.01 881.10 881.11 881.20 881.21 887 903.0 903.1 912.0 912.1 912.2 912.3 912.6 912.7 912.8 912.9 923.0 923.1 927.0 927.1 943 953.4 955.0 955.1 955.2 955.3 955.4 955.5 955.7 955.8 955.9 959.2

Hand and wrist

354.0 716.14 718.04 718.14 718.34 718.84 718.94 719.04 719.14 719.44 726.4 727.63 727.64 733.12 814 815 816 817 833 834 842 881.02 881.12 881.22 882 883 885 886 903.4 903.5 914.0 914.1 914.2 914.3 914.6 914.7 914.8 914.9 915.0 915.1 915.2 915.3 915.6 915.7 915.8 915.9 923.2 923.3 927.2 927.3 944 955.6 959.4 959.5

Leg

716.15 716.16 718.05 718.15 718.35 718.85 718.95 **719.05** 719.15 **719.45 726.5 727.65 733.14 733.15 733.93** 808.0 808.1 820 821 823 835 **843 844.3** 890 897 904.0 904.1 904.2 904.3 904.5 924.0 924.10 928.0 928.10 945.00 945.04 945.06 945.09 945.10 945.14 945.16 945.19 945.20 945.24 945.26 945.29 945.30 945.34 945.36 945.39 945.40 945.44 945.46 945.49 945.50 945.54 945.56 945.59 956 959.6

Knee

717 718.36 718.86 **719.06** 719.16 **719.46 726.6 727.66** 822 836 **844.0 844.1 844.2** 924.11 928.11 945.05 945.15 945.25 945.35 945.45 945.55

Ankle and foot

716.17 718.07 718.17 718.37 718.87 718.97 **719.07** 719.17 **719.47 726.7 727.67 727.68 728.71 733.94 734** 824 825 826 837 838 **845** 892 893 895 896 904.6 917.0 917.1 917.2 917.3 917.6 917.7 917.8 917.9 924.2 924.3 928.2 928.3 945.01 945.02 945.03 945.11 945.12 945.13 945.21 945.22 945.23 945.31 945.32 945.33 945.41 945.42 945.43 945.51 945.52 945.53

Chest, back, and abdomen

720.2 721.7 722.1 722.72 722.73 **724.2** 724.3 724.4 **724.5 724.9** 733.13 805.2 805.3 805.4 805.5 805.6 805.7 806.2 806.3 806.4 806.5 806.6 806.7 807.0 807.1 807.2 807.3 807.4 808.2 808.3 808.4 808.5 808.8 808.9 809 839.2 839.3 839.41 839.42 839.51 839.52 839.61 839.71 **846** 847.1 **847.2 847.3 847.4 847.9** 848.3 848.4 **848.5** 860 861 862 863 864 865 866 867 868 869 875 876 877 878 879.0 879.1 879.2 879.3 879.4 879.5 879.6 879.7 901 902 911.0 911.1 911.2 911.3 911.6 911.7 911.8 911.9 922 926 934 935.1 935.2 936 937 938 939 942 947.1 947.2 947.3 947.4 952.1 952.2 952.3 952.4 953.1 953.2 953.3 953.5 954.1 954.8 954.9 959.1 959.11 959.12 959.19

Environmental

363.31 370.24 388.10 388.11 388.12 692.71 692.76 692.77 910.4 910.5 911.4 911.5 912.4 912.5 913.4 913.5 914.4 914.5 915.4 915.5 916.4 916.5 917.4 917.5 919.4 919.5 990 991 992 993 994

Unspecified

716.10 716.18 716.19 718.00 718.08 718.09 718.10 718.18 718.19 718.30 718.38 718.39 718.80 718.88 718.89 718.90 718.98 718.99 **719.00 719.08 719.09** 719.10 719.18 719.19 **719.40 719.48 719.49** 722.2 722.70 **726.8 726.9 727.2 727.3** 727.60 727.69 728.83 **729.1** 729.2 **733.10 733.16 733.19 733.95** 805.8 805.9 806.8 806.9 819 827 828 829 839.40 839.49 839.50 839.59 839.69 839.79 839.8 839.9 **844.8 844.9 848.8 848.9** 879.8 879.9 884 891 894 903.2 903.3 903.8 903.9 904.4 904.7 904.8 904.9 913.0 913.1 913.2 913.3 913.6 913.7 913.8 913.9 916.0 916.1 916.2 916.3 916.6 916.7 916.8 916.9 919.0 919.1 919.2 919.3 919.6 919.7 919.8 919.9 923.8 923.9 924.4 924.5 924.8 924.9 927.8 927.9 928.8 928.9 929 946 947.8 947.9 948 949 952.8 952.9 953.8 953.9 957.1 957.8 957.9 959.13 959.14 959.3 959.7 959.8 959.9 995.81 995.83 995.85

Note: Bolded codes represent lower extremity overuse injuries.

† *The International Classification of Diseases, Ninth Revision, Clinical Modification, (ICD-9-CM) is a standardized classification system used for coding and classifying diseases, injuries, and conditions diagnosed in the United States.*

APPENDIX C
BARELL INJURY DIAGNOSIS MATRIX AND ASSOCIATED ICD-9-CM 800–999 CODES[10]

				ICD-9-CM Codes	FRACTURE 800-829	DISLOCATION 830-839	SPRAINS/ STRAINS 840-848	INTERNAL 850-854,860-869 952,995.55	OPEN WOUND 870-884, 890-894	AMPUTATIONS 885-887, 895-897	BLOOD VESSELS 900-904	CONTUSION/ SUPERFICIAL 910-924	CRUSH 925-929	BURNS 940-949	NERVES 950-951 953-957	UNSPECIFIED 959
Head and Neck	Traumatic Brain Injury	1	Type 1 TBI	800,801,803,804(.1-.4,.6-.9),(.03-.05,.53-.55) 850(.2-.4),851-854,950(.1-.3),995.55	800,801,803,804(.1-.4,.6-.9) 800,801,803,804(.03-.05,.53-.55)	/	/	850(.2-.4) 851-854*, 995.55	/	/	/	/	/	/	950.1-.3	/
		2	Type 2 TBI	800,801,803,804(.00,.02,.06,.09),(.50,.52,.56,.59),850(.0,.1,.5,.9)	800,801,803,804(.00,.02,.06,.09), 800,801,803,804(.50,.52,.56,.59)			850(.0,.1,.5,.9)								
		3	Type 3 TBI	800,801,803,804(.01,.51)	800,801,803,804(.01,.51)	/	/	/	/	/	/	/	/	/	/	/
	Other head, face, neck	4	Other Head	873(.0-.1,.8-.9), 941.x6, 951, 959.01	/	/	/	/	873.0-.1,.8-.9	/	/	/	/	941.x6	951	959.01*
		5	Face	802, 830, 848.0-.1, 872, 873.2-.7, 941(.x1,.x3-.x5,.x7)	802	830	848.0-.1	/	872, 873.2-.7	/	/	/	/	941.x1,.x3-.x5,.x7	/	/
		6	Eye	870-871, 918, 921, 940, 941.x2, 950(.0,.9)	/	/	/	/	870-871	/	/	918, 921	/	940, 941.x2	950(.0,.9)	/
		7	Neck	807.5-.6, 848.2, 874, 925.2, 941.x8, 953.0, 954.0	807.5-.6	/	848.2	/	874	/	/	/	925.2	941.x8	953.0, 954.0	/
		8	Head, Face, and Neck Unspecified	900, 910, 920, 925.1, 941.x0, .x9, 947.0, 957.0, 959.09	/	/	/	/	/	/	900	910, 920	925.1	941.x0,.x9, 947.0	957.0	959.09
Spine and Back	Spinal Cord (SCI)	9	Cervical SCI	806(.0-.1), 952.0	806.0-.1	/	/	952.0	/	/	/	/	/	/	/	/
		10	Thoracic/Dorsal SCI	806(.2-.3), 952.1	806.2-.3	/	/	952.1	/	/	/	/	/	/	/	/
		11	Lumbar SCI	806(.4-.5), 952.2	806.4-.5	/	/	952.2	/	/	/	/	/	/	/	/
		12	Sacrum Coccyx SCI	806(.6-.7), 952(.3-.4)	806.6-.7	/	/	952.3-.4	/	/	/	/	/	/	/	/
		13	Spine + Back unspecified SCI	806(.8-.9), 952(.8-.9)	806.8-.9	/	/	952.8-.9	/	/	/	/	/	/	/	/
	Vertical Column (VCI)	14	Cervical VCI	805(.0-.1), 839(.0-.1), 847.0	805.0-.1	839.0-.1	847.0	/	/	/	/	/	/	/	/	/
		15	Thoracic/Dorsal VCI	805(.2-.3), 839(.21,.31), 847.1	805.2-.3	839.21,.31	847.1	/	/	/	/	/	/	/	/	/
		16	Lumbar VCI	805(.4-.5), 839(.20,.30), 847.2	805.4-.5	839.20,.30	847.2	/	/	/	/	/	/	/	/	/
		17	Sacrum Coccyx VCI	805(.6-.7), 839(.41-.42), 839(.51-.52), 847.3-.4	805.6-.7	839(.41-.42, .51-.52)	847.3-.4	/	/	/	/	/	/	/	/	/
		18	Spine + Back unspecified VCI	805(.8-.9), 839(.40,.49), 839(.50,.59)	805.8-.9	839(.40,.49,.50,.59)	/	/	/	/	/	/	/	/	/	/
Torso	Torso	19	Chest (thorax)	807(.0-.4), 839(.61,.71), 848(.3-.4), 860-862, 875, 879(.0-.1), 901, 922(.0-.1,.33), 926.19, 942.x1-.x2 953.1	807.0-.4	839.61,.71	848.3-.4	860-862	875, 879.0-.1	/	901	922(.0,.1,.33)	926.19	942.x1-x2	953.1	/
		20	Abdomen	863-866, 868, 879(.2-.5), 902(.0-.4), 922.2,942.x3, 947.3, 953(.2,.5)	/	/	/	863-866, 868	879.2-.5	/	902.0-.4	922.2	/	942.x3, 947.3	953.2, 953.5	/
		21	Pelvis & Urogenital	808, 839(.69,.79), 846, 848.5, 867,877-878 902(.5,.81-.82), 922.4, 926(.0,.12), 942.x5,947.4, 953.3	808	839.69,.79	846, 848.5	867	877-878	/	902(.5, .81-.82)	922.4	926(.0, .12)	942.x5, 947.4	953.3	/
		22	Trunk	809, 879(.6-.7), 911, 922(.8-.9), 926(.8-.9), 942(.x0,.x9), 954(.1,.8-.9), 959.1	809	/	/	/	879.6-.7	/	/	911, 922.8-.9	926.8-.9	942.x0, 942.x9	954.1, .8-.9	959.1
		23	Back and Buttock	847.9, 876, 922(.31-.32), 926.11, 942.x4	/	/	847.9	/	876	/	/	922.31-.32	926.11	942.x4	/	/
Extremities	Upper	24	Shoulder & Upper Arm	810-812, 831, 840, 880, 887(.2-.3), 912,923.0, 927.0, 943(.x3-.x6) ,959.2	810-812	831	840	/	880	887.2-.3	/	912, 923.0	927.0	943.x3-.x6	/	959.2
		25	Forearm, Elbow	813, 832, 841, 881(.x0-.x1), 887(.0-.1), 923.1, 927.1, 943(.x1-.x2)	813	832	841	/	881.x0-x1	887.0-.1	/	923.1	927.1	943.x1-x2	/	/
		26	Wrist, Hand, & Fingers	814-817, 833-834, 842,881.x2, 882, 883, 885-886, 914-915, 923(.2-.3) ,927(.2-.3), 944 ,959(.4-.5)	814-817	833, 834	842 /	/ /	881.x2,882, 883	885-886	/ /	914-915, 923.2-.3	927.2-.3	944 /	/ /	959.4-.5
		27	Other & unspecified	818, 884, 887(.4-.7), 903, 913, 923(.8-.9), 927(.8-.9), 943(.x0,.x9), 953.4, 955, 959.3	818	/	/	/	884	887.4-.7	903	913,923.8,.9	927.8-.9	943.x0,.x9	953.4, 955	959.3
	Lower	28	Hip	820, 835, 843, 924.01, 928.01	820	835	843	/	/	/	/	924.01	928.01	/	/	/
		29	Upper leg & thigh	821, 897(.2-.3), 924.00, 928.00, 945.x6	821			/	/	897.2-.3	/	924.00	928.00	945.x6	/	/
		30	Knee	822, 836, 844.0-.3, 924.11, 928.11, 945.x5	822	836	844.0-.3	/	/	/	/	924.11	928.11	945.x5	/	/
		31	Lower leg & ankle	823-824, 837, 845.0, 897(.0-.1), 924(.10,.21), 928(.10,.21), 945(.x3-.x4)	823-824	837	845.0	/		897.0-.1	/	924.10,.21	928.10,.21	945.x3-.x4	/	/
		32	Foot & toes	825-826, 838, 845.1, 892-893, 895-896, 917, 924(.3,.20), 928 (.3,.20), 945 (.x1-.x2)	825-826	838	845.1	/	892-893	895-896	/	917, 924.3,.20	928.3,.20	945.x1-.x2	/	/
		33	Other & unspecified	827,844(.8-.9), 890-891, 894, 897(.4-.7), 904(.0-.8), 916, 924(.4-.5), 928(.8-.9), 945(.x0,.x9), 959.6-.7	827	/	844.8,.9	/	890-891,894	897.4-.7	904.0-.8	916, 924.4-.5	928.8,.9	945.x0,.x9	/	959.6-.7
Unclassified by Site	Other & unspecified	34	Other/multiple	819, 828, 902(.87,.89), 947(.1-.2), 953.8, 956	819, 828	/	/	/	/	/	902.87,.89	/	/	947.1-.2	953.8, 956	/
		35	Unspecified site	829, 839(.8-.9), 848(.8-.9), 869, 879(.8,.9), 902.9, 904.9, 919,924(.8,.9), 929, 946, 947(.8,.9), 948, 949, 953.9, 957(.1,.8,.9), 959(.8,.9)	829	839.8-.9	848.8-.9	869	879(.8-.9)	/	902.9, 904.9	919, 924.8,.9	929	946, 947.8,.9 948, 949	953.9, 957.1,.8,.9	959.8,.9
	System wide	36	System-wide & late effects	905-908, 909 (.0,.1,.2,.4,.9), 930-939,958, 960-994, 995.50-.54,.59, 995(.80-.85)	Foreign body (930-939), Early complications of trauma (958), Poisoning (960-979), Toxic Effects (980-989), Other and unspecified effects of external cause (990-994) Child and adult maltreatment (995.50-.54,.59, 995.80-.85) Late effects of injuries, poisonings, toxic effects and other external causes (905-909) excluding 909(.3, .5)											

APPENDIX D
INJURY-RELATED MUSCULOSKELETAL MATRIX AND ASSOCIATED ICD-9-CM 710-739 CODES[11]

			Pain and Inflammation	Pain/Inflammation with Nerves	Stress Fracture	Sprains/Strains/Rupture	Dislocation	Other Joint Derangement
Spine and Back	Vertebral Column (VCI)	Cervical VCI	723.1	722.71, 723.4				722.0
		Thoracic/Dorsal VCI		722.72, 724.4				722.11
		Lumbar VCI	724.2	722.73, 724.3				722.10
		Sacrum Coccyx VCI	720.2					
		Spine, Back Unspec. VCI	721.7, 724.5	722.70, 724.9	733.13			722.2
Extremities	Upper	Shoulder	716.11, 719(.01,.11,.41), 726(.0,.1,.10-.12,.19,.2)			727(.61-.62)	718.31	718(.01,.11,.81,.91)
		Upper arm, Elbow	716.12, 719(.02,.12,.42), 726(.3-.33,.39)		733.11		718.32	718(.02,.12,.82,.92)
		Forearm, Wrist	716.13, 719(.03,.13,.43), 726.4		733.12		718.33	718(.03,.13,.83,.93)
		Hand	716.14, 719(.04,.14,.44)			727(.63-.64)	718.34	718(.04,.14,.84,.94)
	Lower	Pelvis, Hip, Thigh	716.15, 719 (.05,.15,.45), 726.5		733(.14-.15)	727.65	718.35	718(.05,.15,.85,.95)
		Lower leg, Knee	716.16, 717.7, 719(.06,.16,.46), 726(.6-.65,.69)		733(.16,.93-.94)	717(.8,.81-.85,.89), 727(.66-.67)	718.36	717,717(.0-.6,.40-.43,.49,.9), 718(.06,.16,.86,.96)
		Ankle, Foot	716.17, 719(.07,.17,.47), 726(.7-.73,.79), 728.71, 734			727.68	718.37	718(.07,.17,.87,.97)
Unclass. by Site	Others and Unspecified	Other specified/Multiple	719(.08-.09,.18-.19,.48-.49), 726.8, 727.2		733.19	727.69	718(.38,.39)	718(.08,.09,.18,.19,.88,.89,.98,.99)
		Unspec. Site	716.10, 719(.00,.10,.40), 726(.9,.90-.91), 727.3, 729.1	729.2	733(.10,.95)	727.60, 728.83	718.30	718(.00,.10,.80,.90)