TB MED 592

TECHNICAL BULLETIN

PREVENTION AND CONTROL OF MUSCULOSKELETAL INJURIES ASSOCIATED WITH PHYSICAL TRAINING

HEADQUARTERS, DEPARTMENT OF THE ARMY

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HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, DC, 1 May 2011

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CHAPTER 1

INTRODUCTION

1–1. Purpose

This bulletin provides guidance to military and civilian health care providers and allied medical personnel to—

a. Understand and implement evidence-based preventive principles to protect U.S. Army personnel from musculoskeletal injuries associated with physical training (PT).

b. Understand the physiologic and pathophysiologic responses to exercise.

c. Understand the risk factors associated with training-related musculoskeletal injuries.

d. Understand interventions with varying levels of evidence for effectiveness in preventing training-related musculoskeletal injuries.

e. Understand the presentation and acute treatment of Soldiers with training-related musculoskeletal injuries.

f. Implement appropriate evaluation and acute treatment for Soldiers with training-related musculoskeletal injuries.

g. Advise commanders on planning, implementing, and evaluating a comprehensive program to reduce musculoskeletal injuries related to PT.

1–2. References

Required and related publications and prescribed and referenced forms are listed in appendix A. A list of open literature is provided in appendix B.

1–3. Explanation of abbreviations and terms

The glossary contains a list of abbreviations and terms used in this publication.

1–4. Roles

a. Unit commanders and noncommissioned officers (NCOs) responsible for unit PT will—

(1) Coordinate to implement educational and training programs at all levels in the command based on the principles of this document.

(2) Review all current PT procedures and unit injury data to assess whether tactically feasible changes can be implemented to reduce training-related injuries and improve the management of injured Soldiers.

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b. Unit commanders will—

(1) Foster a culture of injury risk reduction in all aspects of PT.

(2) Coordinate with the supporting medical officer or medical treatment facility (MTF) commander to receive subject matter expert (SME) consultation (such as from physician assistants, physical and occupational therapists) regarding all unit staff functions related to injury prevention (for example, unit health and medical readiness meetings, occasional monitoring of PT).

(3) Identify and assess training/mission hazards related to PT and musculoskeletal injury, develop and implement prevention interventions, supervise to ensure controls are implemented and monitored, and evaluate effectiveness according to the composite risk management process of Field Manual (FM) 5-19.

(4) Ensure Soldiers receive PT appropriate to their levels of physical conditioning and follow a gradual progression of PT in order to avoid unnecessary overuse injury.

(5) Assume responsibility for all outcomes of PT programs; not just improved physical fitness scores but also resultant injuries. At a minimum, commanders should regularly monitor and report injury profile rates (for example, # of injury profiles / # of Soldiers assigned to the unit) and if possible, determine the cause of these injuries.

(6) Focus on achieving greater unit mission-related physical readiness by placing more emphasis on physically demanding mission-essential training, rather than the Army Physical Fitness Test (APFT) results.

(7) Focus on achieving greater unit physical readiness as a whole by placing more emphasis on improving the unit APFT pass rate (for example, # of Soldiers passing APFT / # Soldiers in the unit) rather than on average unit APFT score.

(8) Monitor physical profiles and enforce activity restrictions therein.

(9) Prohibit use of PT as a punitive, corrective, or disciplinary tool that can lead to overtraining as proscribed in Army Regulation (AR) 350-1.

(10) Ensure Soldiers are monitored for injury, and that those with musculoskeletal complaints or exhibiting signs of musculoskeletal injury receive prompt medical attention.

(11) Facilitate access to ice for medically directed or self treatment of acute musculoskeletal injuries.

(12) Recognize that increased unit injury rates reflect a failure of the PT program (that is, overtraining) as much as a health and readiness problem.

c. In support of the unit commander and under the direction of supporting MTF commander, medical officers and SMEs will—

(1) Understand the commander's intent and mission goals relevant to PT and advise the commander on practical alternatives to current PT practices when existing practices place Soldiers at increased risk for musculoskeletal injury.

(2) Assess the impact of known injury risk factors for Soldiers in the command.

(3) Educate unit commanders and other leaders on injury risk factors, potential interventions to reduce them, how to recognize the early signs and symptoms of musculoskeletal injuries, and how to apply self-treatment techniques.

(4) Assist commanders in analyzing sick call and profile rates, injury incidence, and trends over time, and advising commanders of changes in the health status of the command.

(5) Monitor what types of injuries are being seen at sick call and what medications are being used.

(6) Provide liaison services between command and medical assets to interpret or clarify any ambiguities and coordinate with health providers issuing profiles when uncertainties arise.

(7) Provide direct medical oversight and consultation to unit officers responsible for PT according to FM 21-20 with subsequent changes.

(8) Coordinate training to educate Soldiers in recognizing the signs and symptoms of musculoskeletal injuries and early self-treatment techniques.

(9) Consult with other SMEs in appropriate organizations (Army Physical Fitness School, U.S. Army Center for Health Promotion and Preventive Medicine, U.S. Army Research Institute of Environmental Medicine, Army Physical Fitness Research Institute, physical therapists in MTFs, and others) to access current information on research, doctrine, and innovations related to PT and injury reduction.

d. NCOs responsible for unit PT will—

(1) Conduct PT in a manner that minimizes injuries while achieving physical fitness necessary for mission accomplishment, consistent with the unit commander, FM 21-20, and other approved guidance.

(2) Conduct operational training using composite risk management techniques with proper regard for physical risks and hazards that could result in injury.

(3) Ensure adequate diversity in the PT program and avoid excessive emphasis on running, push-ups, and sit-ups in accordance with AR 350-1 and FM 21-20.

(4) Prevent the abuse of PT as punishment.

(5) Learn the principles of first aid and self care for musculoskeletal injuries, and ensure that Soldiers apply as needed.

(6) Become familiar with signs and symptoms of musculoskeletal injuries, monitor Soldiers during and after training, and facilitate care by the unit medic/medical officer as needed.

(7) Enforce physical profiles.

e. Medics and combat lifesavers will—

(1) Recognize signs and symptoms of musculoskeletal injuries in Soldiers under their care.

(2) Treat Soldiers with musculoskeletal injuries.

f. Soldiers will—

(1) Take responsibility for maintaining their own health and fitness.

(2) Become familiar with signs and symptoms of musculoskeletal injuries, and report as soon as possible to the unit medic/medical officer if symptoms arise.

(3) Learn the principles of first aid and self care for musculoskeletal injuries and apply as needed.

(4) Attend lectures and training sessions for the prevention and management of musculoskeletal injuries.

(5) Practice the buddy system to monitor performance and health.

g. Local medical commands will—

(1) Assist unit commanders in tracking musculoskeletal injuries and, when possible, determine injury cause.

(2) Provide reports as requested by supported commands.

CHAPTER 2

SCOPE OF THE MUSCULOSKELETAL INJURY PROBLEM

2–1. Injury incidence in the Army

a. Injuries can be defined broadly as tissue damage or wounds resulting from a sudden event (trauma) or excessive, repetitive use of a part of the body (overuse). Figure 2–1 shows the size of the overall injury problem in the U.S. Army. About half the deaths, three-fourths of the disability cases, one-fifth of hospitalizations, and one third of all outpatient visits are associated with injuries of all types in the U.S. Army. Injuries lead every other category (illnesses, mental conditions, etc.) for every consequence of injuries in figure 2–1. In just 1 month (June 2005), 8.9, 5.3, 7.3, and 7.3 percent of all Soldiers, sailors, airmen, and marines, respectively, had an injury that required medical attention. These representative rates include combat and non-combat injuries combined. Injuries are by far the leading health problem of the Army across the spectrum of severity from deaths to ambulatory visits.

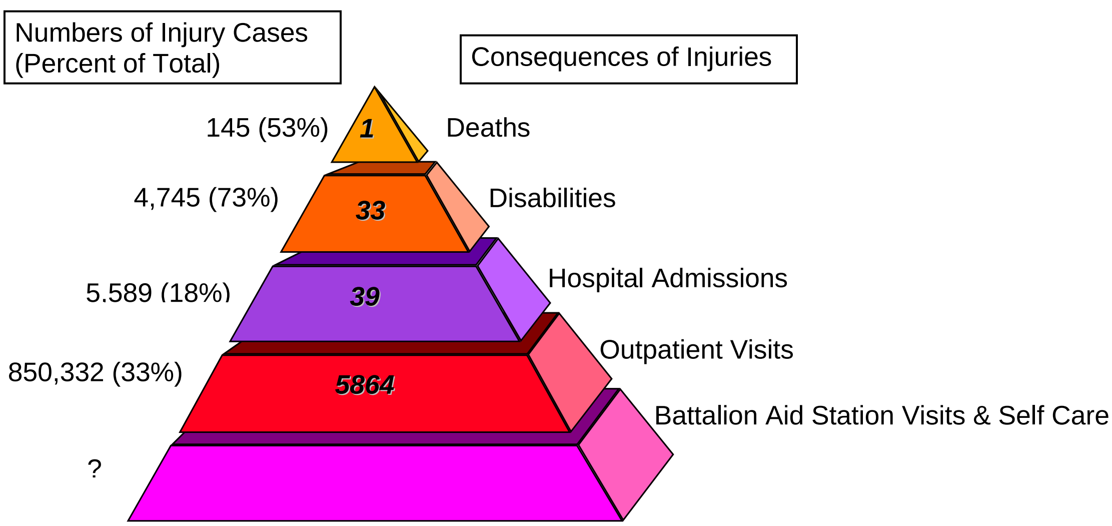

Figure 2–1. The burden of injuries (all types) in the U.S. Army

Numbers on the left are the approximate numbers of injury cases. Numbers in parentheses are injury cases expressed as percentages of the total cases due to all causes in each category. Numbers inside the pyramid are ratios relative to the number of deaths. Calendar year 2002 (CY 02) total: 2,782,685 active duty Army outpatient visits (ADS captured data only).

b. Not all injuries are musculoskeletal, and not all musculoskeletal injuries are caused by PT. However, during basic combat training (BCT) about 25 percent of men and about 50 percent of women incur one or more training-related injuries (table 2–1). Training-related musculoskeletal injuries include minor muscle strains, contusions, tendinopathy, fasciitis, bursitis, muscle or tendon tears or ruptures, joint sprains or complete ligament tears with joint instability, joint dislocation, bone fractures, cartilaginous disruptions, bone stress reactions and stress fractures, and other related injuries. About 80 percent of these injuries are in the lower extremities and are of the overuse type. Common reasons for these types of injuries include excessive PT volume, overuse of a specific muscle group, or muscle groups not given sufficient recovery time.

Table 2–1
Training-related injury incidence during 8 weeks of U.S. Army basic combat training

Location	**Year data collected**	**Injury incidence (%)[1]**		**Injury rate (%/month)[1]**	
		Men	**Women**	**Men**	**Women**
Fort Leonard Wood, MO[2]	2002	29	53	14	27
Fort Jackson, SC[2]	2000	19	42	10	21
Fort Jackson, SC	1998	31	58	16	29
Fort Leonard Wood, MO	1996	40	64	20	32
Fort Jackson, SC	1994	No data	67	No data	34
Fort Jackson, SC	1988	27	57	14	29
Fort Jackson, SC	1984	28	50	14	25
Fort Jackson, SC	1980	23	42	12	21

Notes:
[1]Percent of Soldiers training who sustained an injury.
[2]Data corrected for longer BCT training cycle introduced in October 1998 (extended from 8 to 9 weeks).

c. Injury rates for Soldiers in advanced individual training (AIT) (table 2–2) are similar to the rates seen in BCT, possibly because injuries incurred during BCT are carried over or are first reported during AIT. Longer exposures to PT in the Initial Entry Training (IET) environment are associated with higher injury rates. Injury rates in garrisoned operational units are predictably lower than in BCT or in AIT (table 2–3). It is apparent from injury rates over the past two decades in BCT, AIT, and in operational units that these rates generally have not improved over time (tables 2–1, 2–2, and 2–3).

d. Physical training and sports are activities associated with the largest proportion of injuries. The exact proportions attributable to PT and sports vary by population and location. Various studies report the following: 53 to 63 percent for Soldiers in Ordnance AIT (figure 2–2); 40 percent for armor Soldiers at Fort Riley (figure 2–3); 38 percent for Soldiers in garrison at Fort Lewis; 42 percent for senior officers at the U.S. Army War College; 58 percent for light infantry Soldiers; 52 percent for military policemen; 32 to 34 percent for wheel vehicle mechanics.

Table 2–2
Injury incidence among Soldiers in advanced individual training

Year data collected	Military occupational specialty	Length of training (weeks)	Injury incidence (%)[1]		Injury rate (%/month)[1]	
			Men	Women	Men	Women
2000-2001	Fuel and Electrical System Repairer	9	28	46	12	20
	Field Artillery System Mechanic	10	25	No data	10	No data
	Track Vehicle Mechanic	12	33	50	11	17
	Wheel Vehicle Repairer	13	36	52	11	16
	Track Vehicle Repairer	16	40	60	10	15
1996	Combat Medic	10	24	30	10	12

Note: [1]Calculated based on number of trainees with one or more injuries during training

Table 2–3
Injury incidence rates for U.S. Army Soldiers in operational units

Year data collected	Type of unit	Injury rates[1]	
		New injuries	Clinic visits for injuries
2004	Wheel Vehicle Mechanics	Men 10.3 Women 13.0	Men 18.6 Women 19.7
2002	Armor	5.7	11.0
2002	Military Police	9.2	19.2
1997-1998	Infantry	8.4	No data
1996	Combat Engineers Artillery	No data No data	16.8 12.3
1989-1990	Infantry	No data	15.1
1989 [2]	Infantry	11.8	18.3
1984-1985 [3]	Infantry Special Forces Rangers Aviation/Artillery	11.2 12.1 10.1 4.5	No data No data No data No data

Notes:
[1]Injured Soldiers per 100 Soldier-months of training
[2]Originally based on 6 months of data collection
[3]Originally based on 8 weeks of data collection

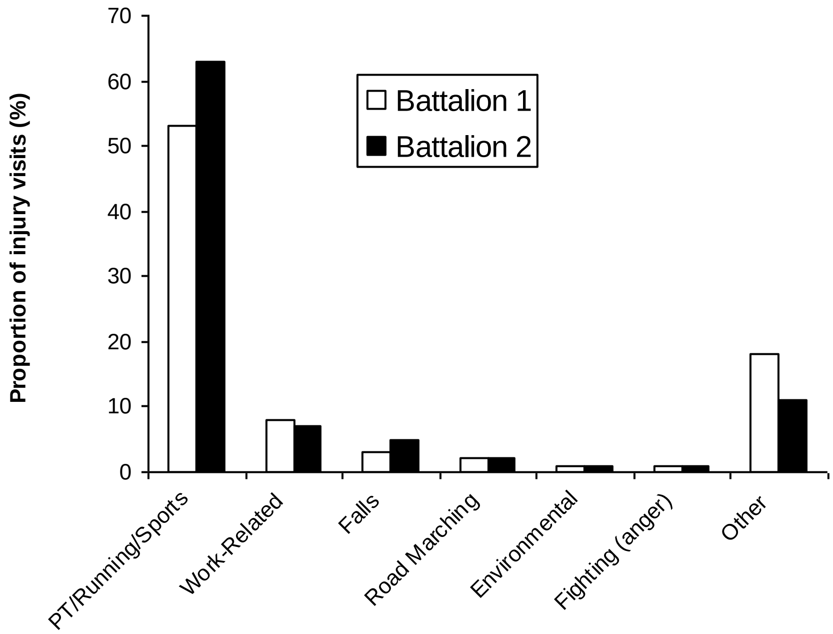

Figure 2–2. Activities associated with injury in U.S. Army Ordnance AIT
**** PT = Physical Training. Activities were unknown for about 12% of injury visits in either battalion***

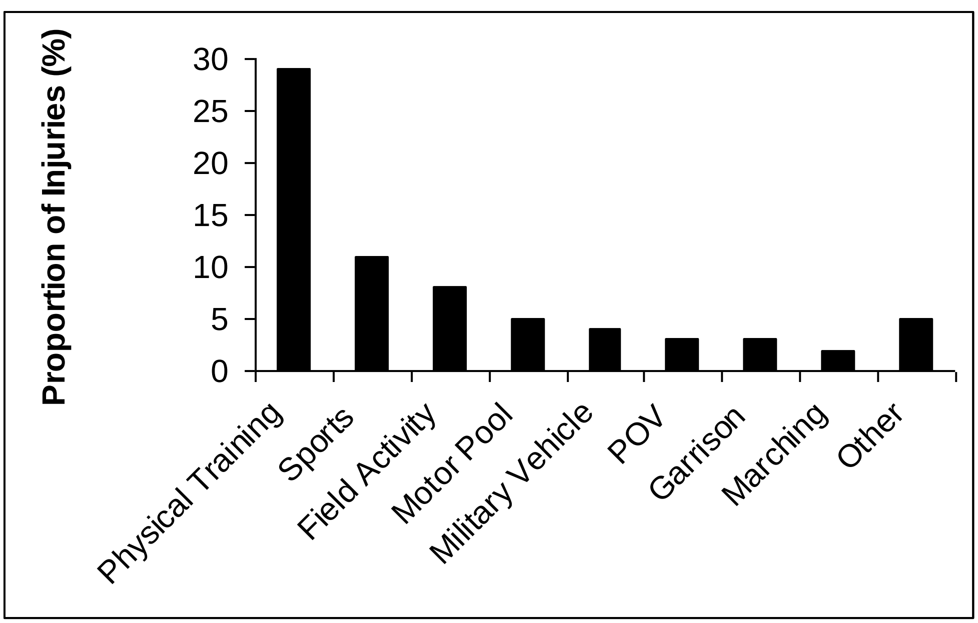

Figure 2–3. Activities associated with injury in U.S. Army armor Soldiers. Activities were unknown for 30% of injuries

2–2. Hospitalizations and outpatient clinic visits

a. Acute musculoskeletal injuries and chronic musculoskeletal conditions arising from injuries are consistently the leading causes of hospitalizations and outpatient visits in the Army. In 1992, there were 28.1 hospitalizations per 1,000 Soldiers per year for musculoskeletal conditions. This rate was higher than any other principal diagnosis group and represents a 75 percent increase over the previous decade. The Army's rate of hospitalizations for musculoskeletal conditions is more than twice that of the Air Force and almost three times that of the Navy. These differences may be due to differences in the types of training and duty performed by each service, or may reflect differences in reporting.

b. Most musculoskeletal injury hospitalizations in the Army are for serious recurrent or chronic effects of injuries such as internal knee derangement (the single leading cause of hospitalization), intervertebral disc disorders, or osteoarthritis. Although cause and effect relationships have not been definitively demonstrated, many Soldiers attribute chronic conditions of this nature to prior overuse or traumatic injuries sustained over time during PT, athletics, or sports. Causes for chronic musculoskeletal conditions are likely multifactorial, including as-yet unspecified combinations of occupational, genetic, environmental, and other risk factors.

c. Physical training, athletics, and sports, combined, are the third leading cause of musculoskeletal injury requiring hospitalization. In 1992, there were 3.49 hospitalizations per 1,000 Soldiers per year for injuries due to PT or sports in the Army. This accounts for 14 percent of injury hospitalizations for all causes. Physical training, sports, and athletics accounted for 18 percent of all U.S. Army injury hospitalizations during the Persian Gulf War.

d. In 2003, there were 2,473,327 outpatient visits to Army MTFs. Of these, 750,505 (30.3 percent) were for injuries and other musculoskeletal conditions. Soldier outpatient clinic visits for injuries are about the same as the number of visits for illnesses in BCT and among infantry units: generally about 80 to 100 injury visits per 100 Soldiers per year. The highest injury incidences occur on BCT installations and are 1.4 to 2.2 times higher than the overall Army installation average. Most injuries during BCT appear to be associated with PT activities (running and marching) and primarily involve the lower extremities. Clinic visits for these injuries typically result in a physical profile limiting duty for the Soldier as part of the treatment plan.

2–3. Disabilities

a. Disabilities are a huge and worsening problem in the Army. Over the past two decades, disability discharge rates for all diagnoses combined increased about 300 percent from 68 per 10,000 Soldiers per year in 1982 to 270 per 10,000 Soldiers per year in 2002 (figure 2–4).

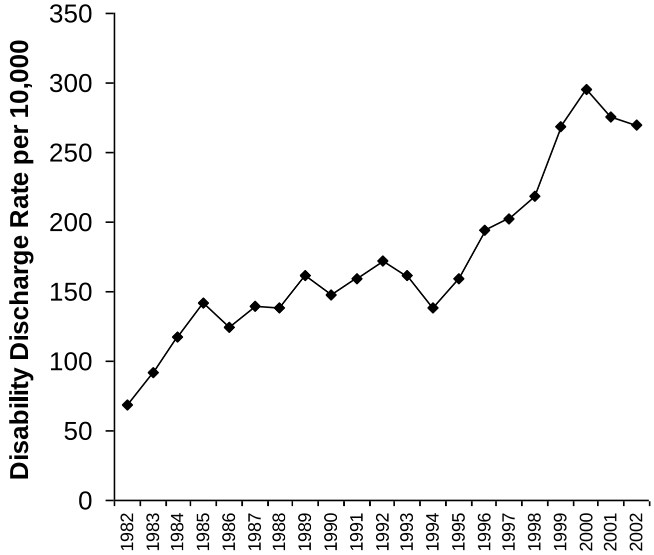

Figure 2–4. Disability rates for Army Soldiers, all diagnoses and genders combined, 1980-2002

b. Costs of disabilities are staggering. The Veterans Administration (VA) reported in 2001 that annual compensation costs paid directly to disabled service members from all services totaled over $21 billion. Of these payments, over $5.5 billion are direct payments to Soldiers, Sailors, and Airmen with musculoskeletal disabilities. Costs for medical care related to these disabilities are in addition to these direct compensation costs. The proportion of these disabilities attributable to injuries sustained in PT is unknown. The proportions of these disabilities attributable to single episodes of trauma versus chronic, repetitive overuse or other causes are also unknown.

c. Musculoskeletal system disorders are the leading cause of disability cases in the Army, constituting 73 percent of the total disability cases for all causes from 1997-2002. Knee and spine are the body regions with the highest percentages of total disability cases. The proportion of these cases attributable to injuries sustained in PT is unknown.

d. Women in the Army are more likely to be disabled than men. Women are approximately 64 percent more likely than men to receive a physical disability discharge of any type and approximately 67 percent more likely than men to receive a physical disability discharge for a musculoskeletal disorder.

e. The past two decades have seen a dramatic and disproportionate increase in disability discharge rates attributable to musculoskeletal causes for both men and women. Figure 2–5 demonstrates that disability discharge rates for musculoskeletal conditions exceed discharge rates for all other conditions combined. Among the 14 nonmusculoskeletal categories the 3 most common diagnoses were respiratory, neurological, and mental conditions — not one of which had an individual category discharge rate greater than 15 per 10,000 Soldiers per year for any

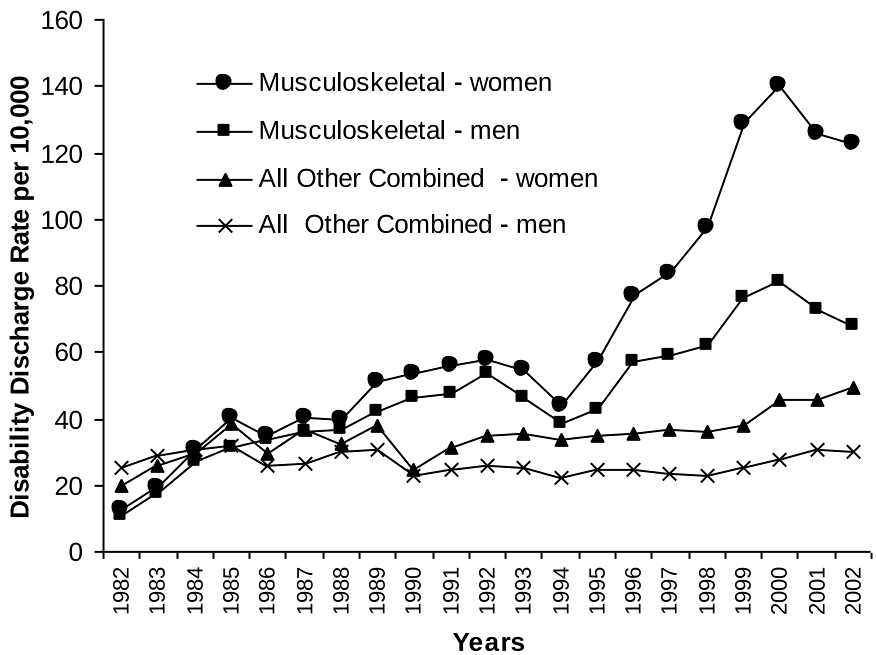

Figure 2–5. Disability rates for Army Soldiers, grouped by gender and diagnosis category (musculoskeletal vs. all other), 1982-2002

given year. This compares with discharge rates as high as 140 per 10,000 female Soldiers per year and 81 per 10,000 male Soldiers per year for musculoskeletal conditions during the same period.

2–4. Lost or limited duty time

a. Musculoskeletal injuries in the Army result in over 400,000 medical profiles annually. The average number of limited duty or nonduty days resulting from outpatient visits for injuries is 5 to10 times the average lost or limited duty days associated with outpatient visits for illness. For the entire Army in CY 01, 46 percent of all injuries were characterized as time-loss injuries. One study of Soldiers in AIT found that 84 to 86 percent of all outpatient visits for injuries resulted in a medical profile. Lower extremity overuse injuries account for the majority of training-related injuries seen in outpatient clinics.

b. In one study of 181 Soldiers in a light infantry unit, 55 percent of the Soldiers suffered at least one injury over the course of 1 year. Among clinic visits for injuries of all types, 88 percent were for musculoskeletal injuries attributed to PT or vigorous operational activities. These musculoskeletal injuries resulted in an annualized 1,287 days of lost or limited duty time: an average of 7.1 lost or limited duty days per infantryman per year.

c. Hospitalizations for musculoskeletal conditions result in more days of nonduty time than any disease group. Between 1989 and 1994, hospitalizations due to injuries sustained in Army

PT or with sports resulted in an average of 29,435 lost Soldier duty days per year. Thus, these injuries are a major detriment to readiness in the Army.

2–5. Conclusions about injuries in the Army

a. Injuries represent the leading cause of deaths, disabilities, hospitalization and outpatient visits in garrison, and medical evacuations during combat operations. As such, injuries are the biggest health problem in the Army.

b. The fact that injuries account for more days of limited duty than any other cause means they have a bigger impact not only on health but also on readiness in the Army.

c. A problem of this magnitude requires a concrete, systematic effort: first to prevent injuries and second, to manage injuries when they do occur. The following sections describe the nature of the injury problem and approaches that can be used to prevent and manage musculoskeletal injuries associated with PT.

CHAPTER 3

PHYSIOLOGIC AND PATHOPHYSIOLOGIC MUSCULOSKELETAL RESPONSES TO PHYSICAL TRAINING

3–1. Role of physical fitness in military operations

a. Physical fitness has a direct impact on combat readiness. Physical fitness programs assist in preparing Soldiers for warfighting by increasing strength, endurance, and mobility. Many additional benefits derive from military PT: unit cohesion, greater mental alertness and productivity, invigoration of the overall training program, and increased combat readiness.

b. Many historical examples highlight the importance of PT for Soldiers. From earliest recorded history until the present time, accounts of warfare have chronicled high physical demands for all aspects of warfighting.

c. One measure of physical requirements of a job is the physical lifting demands. The physical lifting demand of each military occupational specialty (MOS) is characterized by placing it into one of five categories based on lifting requirements from the U.S. Department of Labor. Nearly half of entry-level MOSs in the Army are rated “very heavy” which is the highest physical demand category. In the “very heavy” category, lifting demands exceed 100 pounds occasionally and 50 pounds frequently.

d. Another measure of the physical requirement of a job is the load carriage requirement. Soldiers engaged in combat frequently exceed the load carriage recommendations described in Army doctrine (FM 21-18). For example, average loads carried by combat infantrymen engaged in Operation Enduring Freedom in 2003 exceeded recommended maximums in all load configuration categories (table 3–1). Although PT has been shown to improve load carriage performance, it is unclear whether enhanced physical fitness confers protection against the assumed increase in musculoskeletal injury risk from excessive combat load carriage.

e. Current doctrine for the Future Force Warrior calls for deploying physically fit Soldiers who are truly physiologically adaptable and capable of serving relatively long periods of time in austere and harsh environments with little or no prior acclimation preparation. These Soldiers must arrive in the battlespace ready to fight or conduct other full spectrum operations immediately upon arrival. Forces must be capable of conducting continuous operations for up to 3 days at high operational intensity. Only a high level of physical readiness will enable America’s warfighters to meet this expectation.

3–2. Beneficial adaptations to physical training

a. A number of physiologic, metabolic, and psychological benefits have been shown to accrue from physical fitness training (table 3–2). Exercise and higher levels of physical fitness are also associated with lower risks for a number of chronic diseases (table 3–3).

Table 3–1
Recommended vs. actual load carriage in combat

	Maximum load recommendations, FM 21-18 (pounds)	Average combat loads: Operation Enduring Freedom, 2003 (pounds)
Fighting load	48	63 (35% body weight)
Approach march load	72	101 (57% body weight)
Emergency approach march load	120 (for several days up to 20 km marches) 150 (fatigue, injury probable)	132 (78% body weight)

Table 3–2
Physiologic, metabolic, and psychological benefits of physical fitness training[1]

Benefits from endurance exercise	Benefits from resistance exercise
Increased stamina due to central and peripheral adaptations	Increased muscle strength
Lower respiration (minute ventilation) at a given submaximal intensity	Increased size of muscle fibers
Lower heart oxygen cost for a given absolute submaximal intensity	Greater movement speed
Lower heart rate and blood pressure at a given submaximal intensity	Improved anaerobic capacity
Increased blood supply (capillary density) in skeletal muscle	Increased bone strength
Increased maximum work capacity and power output	Increased bone mass
Increased capacity for prolonged work	Increased bone mineral density
Increased serum high-density lipoprotein cholesterol and decreased serum triglycerides	Increased size and strength of tendons, ligaments, and fascia (postulated)
Reduced total body and intra-abdominal fat	Increased work capacity and power output
Reduced insulin needs; improved glucose tolerance	Fosters psychological well-being
Heat acclimation	Decreased muscle soreness from heavy work
Decreased depression and increased well being	

Note: [1]Adapted from Franklin B, ed. *ACSM's Guidelines for Exercise Testing and Prescription*. 6 ed. Philadelphia: Lippincott Williams & Wilkins; 2000 and Baechle TR, Earle RW. *Essentials of Strength Training and Conditioning*. Champaign, Illinois: Human Kinetics; 2000.

Table 3–3
Relationship between physical activity or physical fitness and chronic disease incidence[1]

Disease or condition	Number of studies	Trends across activity or fitness categories and strength of evidence
All-cause mortality	***[2]	↑↑↑[5]
Coronary artery disease	***[2]	↑↑↑[5]
Hypertension	**[3]	↑↑[6]
Obesity	***[2]	↑↑[6]
Stroke	***[2]	↑[7]
Peripheral vascular disease	*[4]	→[8]
Colon cancer	***[2]	↑↑↑[5]
Rectal cancer	***[2]	→[8]
Stomach cancer	*[4]	→[8]
Breast cancer	**[3]	↑[7]
Prostate cancer	***[2]	↑[7]
Lung cancer	*[4]	↑[7]
Pancreatic cancer	*[4]	→[8]
Type 2 diabetes mellitus	**[3]	↑↑[6]
Osteoarthritis	*[4]	→[8]
Osteoporosis	**[3]	↑↑[6]
Depression	*[4]	↑[7]

Notes:
[1]Adapted from Franklin B, ed. *ACSM's Guidelines for Exercise Testing and Prescription.* 6 ed. Philadelphia: Lippincott Williams & Wilkins; 2000. ©Copyrighted. Wolters Kluwer. 2000. All Rights Reserved.
[2]*** more than 10 studies
[3]** approximately 5-10 studies
[4]* few studies
[5]↑↑↑ excellent evidence of reduced disease rates across activity or fitness categories
[6]↑↑ good evidence of reduced disease rates
[7]↑ some evidence of reduced disease rates
[8]→ no apparent difference in disease rates across activity or fitness categories

b. Improvements in occupational task performance have been shown to accrue from PT. Physical training programs designed specifically to improve particular occupational tasks generate greater task performance benefits than general PT programs. For example, task-specific lifting training yielded lifting performance improvements of 26 to 183 percent, whereas general PT improved lifting performance 16 to 32 percent. Higher levels of strength in relation to job demands are associated with fewer job-related injuries in studies from industry and military settings.

3–3. Maladaptations to physical training leading to musculoskeletal injuries

a. A sudden, unexpected event that causes trauma can produce acute injuries during training. Whenever forces applied to tissues exceed the inherent capability to absorb and dissipate those forces, structural tissue failure will result. Examples are acute ankle sprains due to exercising on uneven ground, contusions due to falls, fractures, and dislocations due to falls.

b. With a gradually progressive exercise program, body tissues slowly adapt to the stress of the exercise so there is little or no damage. If there is slight damage, it is repaired rapidly with little pain and no loss of function. Overuse injuries are caused by excessive use of a part of the body that puts strain on the tissues such that they can no longer adapt with a healthy response. The ability of cells to repair damage is overwhelmed by the repetitive microtrauma. Overuse injuries develop over the course of weeks or months of repetitive activities such as PT, and may also be influenced by exposure to other occupational risk factors. Three examples that are representative of this process are delayed onset muscle soreness (DOMS), tendinopathy, and bone stress injuries.

(1) DOMS is extremely common among unfit individuals who initiate a PT program and progress too rapidly. Symptoms of muscle tenderness, stiffness, swelling and pain generally peak within 24 to 48 hours after exercise (particularly so with eccentric exercise), and usually subside within 5 to 7 days without treatment. However, muscle strength, motor control, flexibility, and task performance are impaired during the symptomatic period. Blood creatine kinase levels are elevated with DOMS, indicating muscle fiber damage with disruption or permeability changes in the plasma membrane. Physiologic mechanisms related to DOMS are poorly understood, but several theories have been proposed. These include maladaptations involving muscle spasm, connective tissue damage, muscle damage, inflammation, and enzyme efflux. Although the presence of muscle edema suggests that DOMS involves an inflammatory process, anti-inflammatory drugs in general have not been shown to be effective in improving strength or performance.

(2) With tendinopathy, the structure of the tendon is disrupted by repetitive strain. Collagen fiber cross-links begin to break and denature the tissue. This cumulative microtrauma also degrades noncollagenous matrix and the vascular elements of the tendon which leads to inflammation and pain. Acute tendonitis is characterized by inflammatory cell reaction, edema formation, and circulatory impairment. Crepitus, caused by movement of a tendon within a paratenon filled with fibrin exudate, may be present. If acute inflammation persists, adhesions may form to the tendon or surrounding fascia. This may lead to chronic tendinopathy characterized by persistent pain and diminished function. Eventually, decreased circulation, local hypoxia with impaired nutrition, and a persistent inflammatory reaction may lead to tendon degeneration or rupture. Local release of cytokines and a proliferation of myofibroblasts are also implicated in chronic tendinopathy. Common sites affected in Soldiers are the Achilles, patellar, supraspinatus, and biceps brachii (long head) tendons.

(3) As with soft tissue overuse injuries, bone stress fractures generally result from repetitive microtrauma that exceeds the intrinsic ability of bone to repair itself. One theory holds that during the initial increase in PT, osteoblastic (rebuilding) activity lags behind osteoclastic (breakdown/remodeling) activity by a few weeks and results in bone that is more susceptible to

injury. Bending and twisting forces from repetitive training produce stress fractures. Another theory emphasizes strong and repetitive stress on bone at the insertion points of muscles that results in focal bending stresses exceeding structural and physiologic tolerance of bone. Stress fractures may produce local swelling or periosteal thickening. Common symptoms are dull pain not associated with trauma that worsens with weight bearing or exercise. Point tenderness to palpation is usually present at the injury site. Tibial fractures are the most common lower extremity stress fracture which accounts for approximately one-half of all stress fractures. Metatarsal fractures represent approximately 25 percent of stress fractures. Femoral stress fractures have potentially serious consequences and may require surgery. These less common but serious injuries may refer pain to the groin, anterior thigh, or knee and will usually present painful hip motion and abnormal gait.

CHAPTER 4

RISK FACTORS ASSOCIATED WITH PHYSICAL TRAINING INJURIES

4–1. Intrinsic risk factors

a. Intrinsic risk factors are those related to personal characteristics of the individual Soldier. Extensive research has revealed intrinsic risk factors for injury in BCT (table 4–1). Studies show consistently that women are more likely to be injured than men. Multivariate analyses have consistently shown that low levels of aerobic fitness (figure 4–1), low push-up performance (figure 4–1), cigarette smoking (figure 4–2), and low levels of physical activity (for men only) are independent risk factors for injuries during BCT. Several studies have documented a higher incidence of lower extremity injuries for those who have had previous similar injuries (figure 4–3).

Table 4–1
Intrinsic risk factors for injury in BCT

	Risk factors
Strong evidence	Female gender[1]
	Low aerobic fitness[1]
	High and low extremes of flexibility[2]
	Low levels of physical activity prior to BCT[2]
	Cigarette smoking prior to BCT[1]
Moderate evidence	Very high and very low foot arches[2]
	Knee Q-angle >15 degrees[2]
	Genu valgus[2]
	Past ankle sprains[2]
	Low muscular endurance[1]
	Older age[3]
Weak evidence	Lower levels of muscular strength[2]
	Body mass index (BMI)[4,2]
	White ethnicity[1]

Notes:
[1]Five or more studies
[2]Few studies
[3]Older age is a risk factor in BCT but protective in infantry units
[4]Studies suggest that both extremes of BMI are associated with injury but this is not clear. Larger risk appears to be with higher BMI.

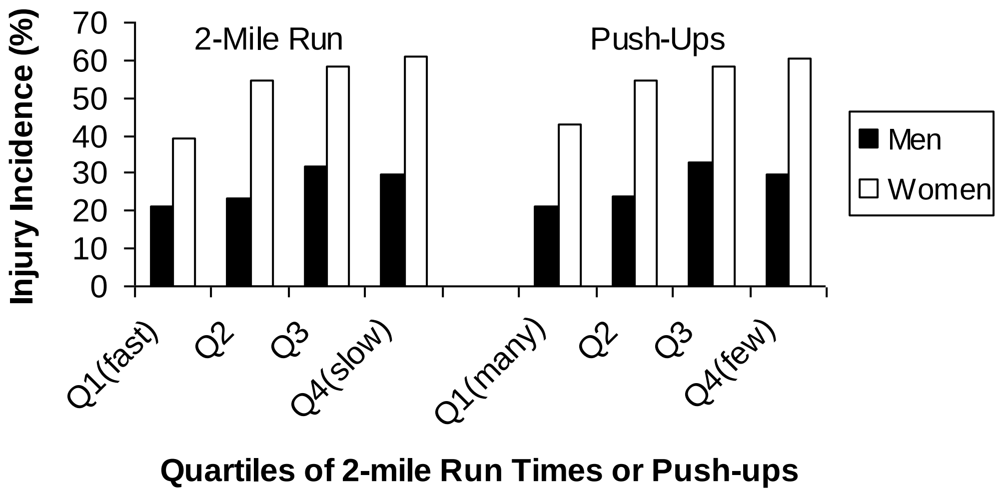

Figure 4–1. Association of maximal effort 2-mile run times, push-ups, and injury during BCT

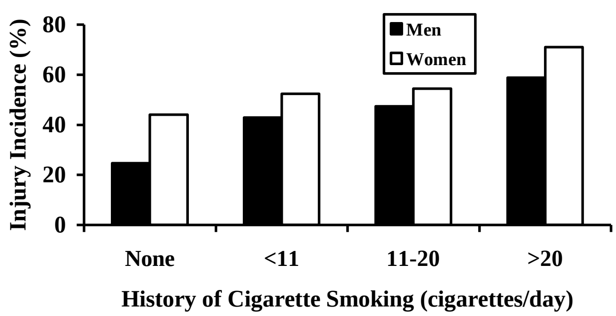

Figure 4–2. Association of cigarette smoking history and injury

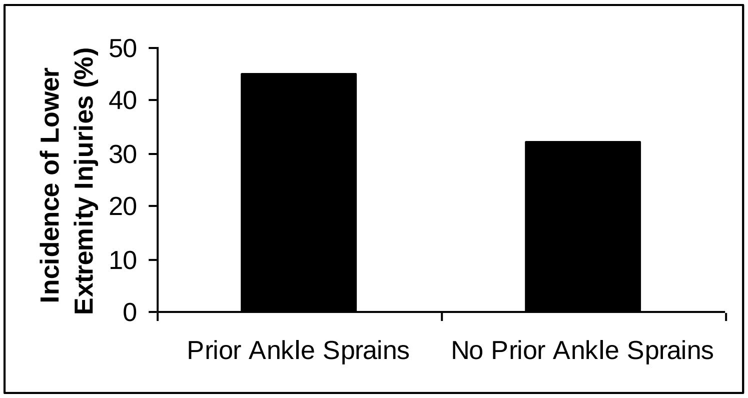

Figure 4–3. Association of prior ankle sprains and recent sprains

b. Injury risk factors among AIT Soldiers have not been characterized as well as for Soldiers in BCT, but combat medics and ordnance Soldiers have been studied. In medic AIT, injury risk factors among women include older age, split option (a 1-year break in military service between BCT and AIT), and higher body mass (figure 4–4). In ordnance, AIT risk factors for overuse injuries include lower military rank, self-reported prior injury, cigarette smoking before BCT, low muscular endurance, and low aerobic fitness.

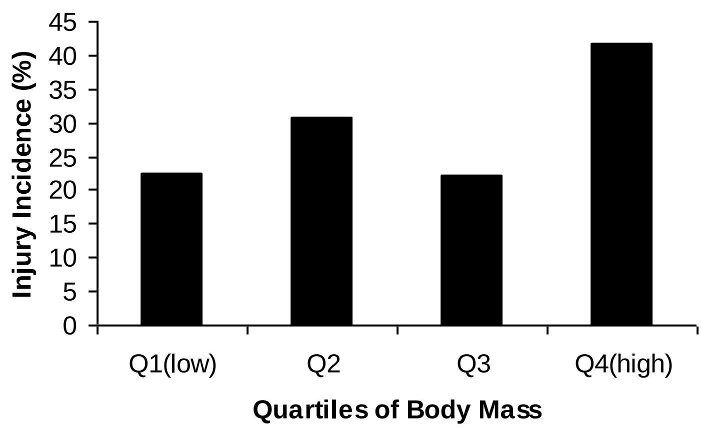

Figure 4–4. Association of body mass and injury rates among female Soldiers in Combat Medic AIT

c. Although it has long been assumed that all Soldiers should perform stretching exercises to avoid injuries associated with a lack of joint flexibility, pre-exercise stretching applied indiscriminately to large groups has been shown to provide no protection against injury. Research has shown that increased injury rates are associated with too little and too much flexibility (figure 4–5). These findings have been repeated in studies of Army basic trainees, Navy sea-air-land (SEAL) trainees, and collegiate athletes. This suggests the need for further research to discover whether subsets of Soldiers with low flexibility might have fewer musculoskeletal injuries by using targeted stretching exercises.

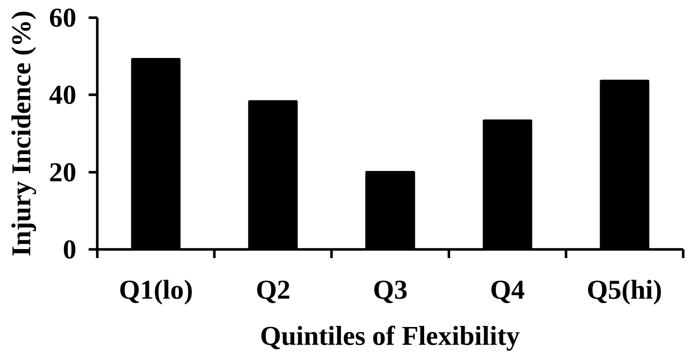

Figure 4–5. Association of flexibility and injury

d. Occupational military groups that have been studied include infantry Soldiers, military policemen, armor Soldiers, combat engineers, field artillerymen, and light-wheel vehicle mechanics. Although there are commonalities, different occupational specialties have different risk factor profiles; this may reflect distinctive occupational demands. Infantry Soldiers are more likely to experience injuries if they have low aerobic fitness, low performance on sit-ups (figure 4–6), are cigarette smokers, have high levels of body fat, or if they are younger. Cigarette smoking and slow 2-mile run times are independent injury risk factors among these Soldiers. In male military policemen, armor crewmen and mechanics, high BMI is associated with higher injury rates (figure 4–7). Younger age is an injury risk factor for both infantry Soldiers and military police, possibly because younger (generally lower ranking) Soldiers are more likely to be those performing physical activity and are therefore more exposed to physical hazards.

e. Among combat engineers and field artillery Soldiers, lower extremity pain is associated with short stature and white ethnicity; low back pain is associated with high body mass; and sprains and strains are associated with short stature and high BMI.

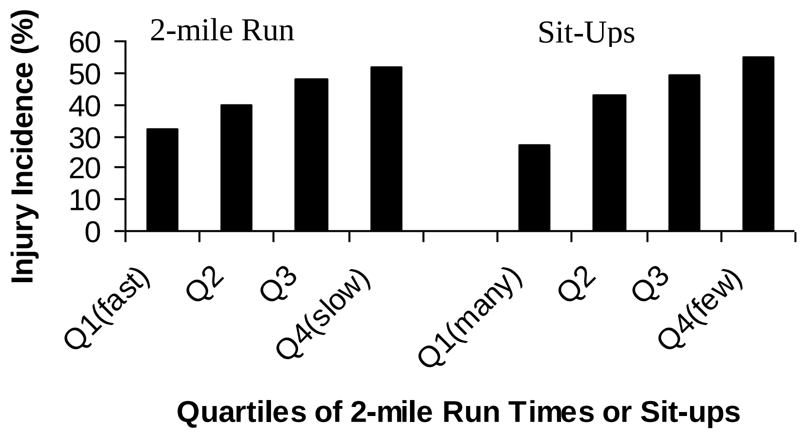

Figure 4–6. Association of maximal effort 2-mile run times, sit-ups, and injury in infantry Soldiers

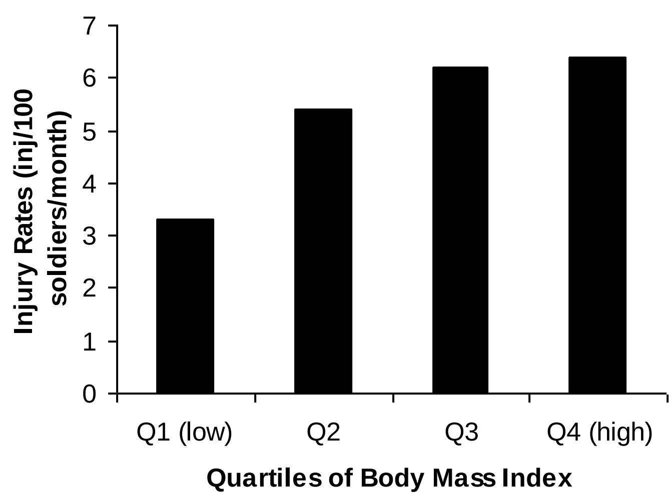

Figure 4–7. Association of body mass index and injury rates among male armor crewmen

f. Levels of satisfaction with assignment, job, and life in general appear to be associated with injury incidence. Data presented in figure 4–8 are from senior officers attending the U.S. Army War College. Data from Soldiers attending the U.S. Army Sergeants Major Academy suggest significant relationships between occurrence of traumatic injury and the following psychological variables: tension/anxiety scores, self-reported sleep disturbance, and the Type A behavior pattern. Psychological factors are also important predictors for Soldiers discharged from the U.S. Army with disability related to occupational low back pain. Soldiers in one study reporting

Figure 4–8. Association of job and life satisfaction with injury incidence in senior officers

higher work stress, worries, or lower social support were two to five times more likely to be discharged with back-related disability than Soldiers without those psychological profiles.

4–2. Extrinsic risk factors

Extrinsic risk factors are those related to the environment or activities external to the Soldier. The most striking finding in BCT is that the more running a unit performs the higher the likelihood of injuries. Figure 4–9 demonstrates the relationship between running mileage and injury incidence with civilian men and women recreational runners. There are large differences in injury rates among BCT training companies associated with running distance (figure 4–10). Older running shoes are associated with a higher risk of stress fractures (figure 4–11), which is possibly related to the age-related loss of shoe cushioning and support. Seasonal variations in injury rates appear to occur in BCT with higher overall rates in the summer and lower rates in the fall (figure 4–12); this may be associated with higher summer temperatures. A graphic summary of the Soldier most susceptible to injury is shown in figure 4–13.

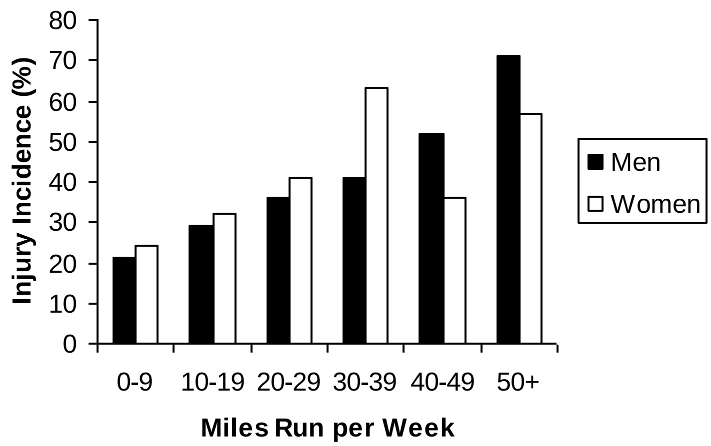

Figure 4–9. Injuries among men and women by number of miles run

(Adapted from Koplan JP, Powell KE, Sikes RK, Shirley RW, Campbell CC. An epidemiologic study of the benefits and risks of running. *JAMA.* 1982 Dec 17;248(23):3118-21.)

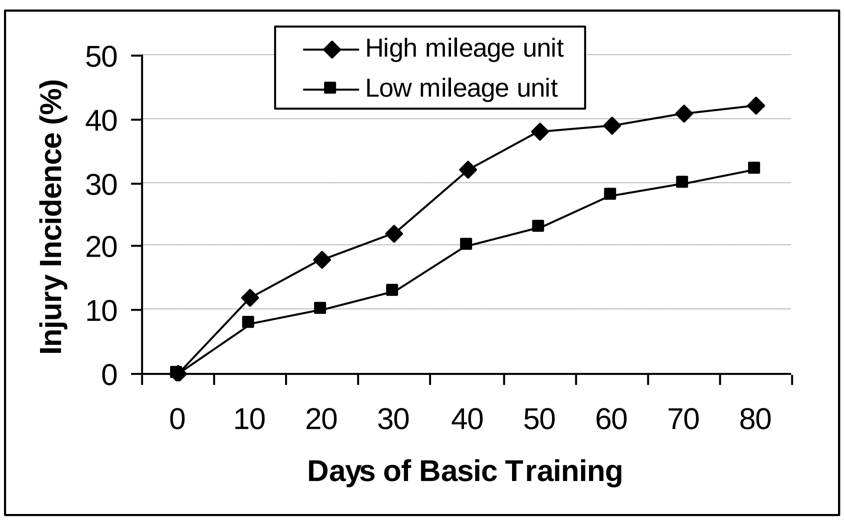

Figure 4–10. Cumulative incidence of injury by cumulative days of training in BCT

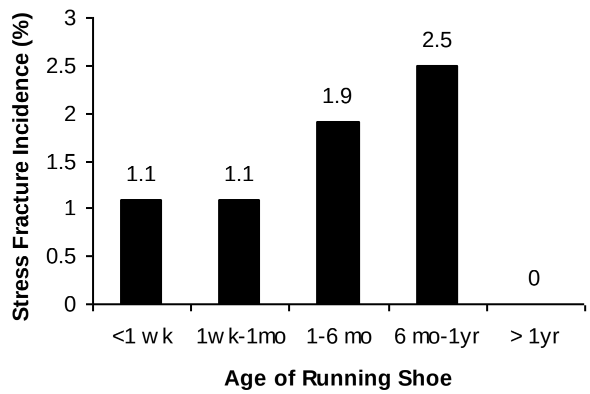

Figure 4–11. Lower extremity stress fracture incidence among 3,025 U.S. Marine recruits, stratified by running shoe age

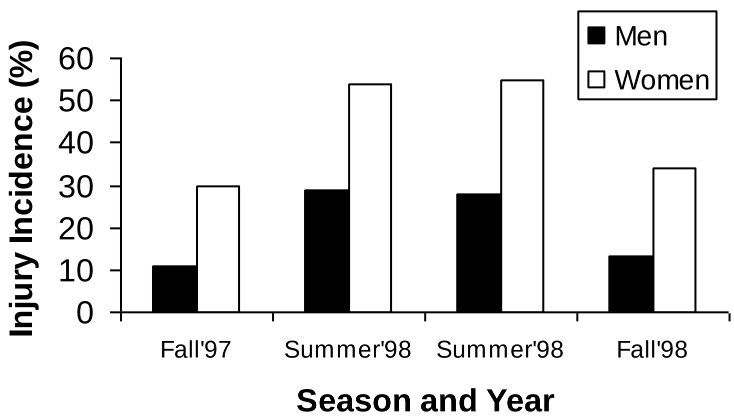

Figure 4–12. Incidence of injuries in the fall and summer during BCT

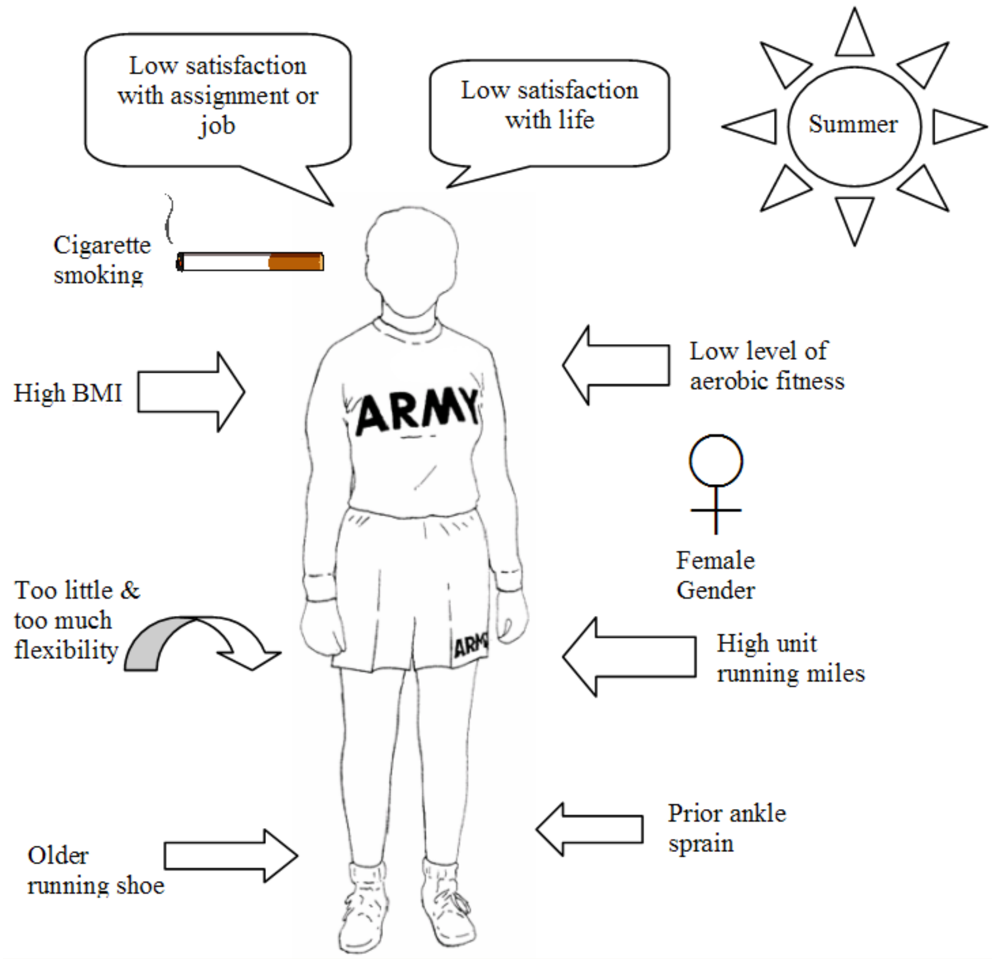

Figure 4–13. Summary of internal and external risk factors for musculoskeletal injuries related to physical training

CHAPTER 5

INTERVENTIONS FOR MUSCULOSKELETAL INJURY PREVENTION

5–1. Modifications to physical training

a. Running mileage. Given the very strong evidence showing higher running mileage as an injury risk factor, an obvious intervention is to reduce the amount of running performed by Soldiers. This intervention has been tested experimentally among recruits in 12-week Marine Corps boot camp. Table 5–1 shows the running distances, stress fracture incidence, and final 3-mile run times for three groups of U.S. Marine recruits, with each group performing different amounts of organized running. A 40 percent reduction in running distance was associated with a 53 percent reduction in stress fracture incidence and only slightly (3 percent) slower run times. Thus, reducing running mileage reduced stress fracture incidence with minimal effects on aerobic fitness. Equating miles of running for the Marine recruits with the lowest stress fracture rate in table 5–1 yields a total of 25 running miles for the 9-week Army BCT cycle. In a study of Army BCT, one battalion running a total of 17 miles plus an undetermined amount of interval training had lower injury rates and similar improvements in 2-mile run times compared to a battalion that ran a total distance of 38 miles. Another study compared male Naval recruits assigned to basic training divisions that ran either 12 to 18 miles or 26 to 44 miles. The lower mileage division had lower injury rates and 1.5-mile run time improvements that were the same as the higher mileage divisions. Similar results were obtained with Australian Army recruits when running was replaced with a graduated program of foot marches with backpack loads. This intervention reduced all lower limb injuries by 43 percent and knee injuries by 53 percent. The U.S. Army Training and Doctrine Command Initial Entry Training Standardized Physical Training Guide (TRADOC IET SPT Guide) has been implemented at all Army IET sites. Studies conducted prior to implementation showed that this program reduced injuries by 21 percent compared to a traditional BCT PT program. The TRADOC program incorporates less running mileage, a greater variety of exercises, and no stretching prior to PT.

Table 5–1
Mileage, stress fracture incidence, and final 3-mile run times among three groups of male U.S. Marine Corps Recruits

Marines (n)	Total run distance over 12 weeks (mi)	Stress fracture incidence (n/100)	Final 3-mile run times (min)
1136	55	3.7	20.3
1117	41	2.7	20.7
1097	33	1.7	20.9

b. Running duration and frequency. There are physiological thresholds above which increases in running duration and frequency do not result in a commensurate increase in fitness, but *do* result in higher injury rates (particularly for people with average and below average fitness levels). Among previously sedentary young adult males, running above known thresholds for duration and frequency dramatically increases risk of injury with little improvement on maximal oxygen uptake (a measure of cardiovascular endurance that correlates with run-time performance) or estimated 2-mile run times. Table 5–2 indicates that running duration of 45 minutes versus 30 minutes increases the injury incidence (percent of subjects injured) by 125 percent (over 2-fold) with only a 5 percent increase in maximal oxygen uptake (or an estimated 18 seconds faster on a 2-mile run). Table 5–3 indicates that a running frequency of 5 times per week versus 3 times per week increases the injury incidence by 225 percent (over 3-fold) with only a 35 percent increase in maximal oxygen uptake (or an estimated 36 seconds faster on a 2-mile run). The bottom line is that the amount of running can be dramatically reduced to prevent injuries without proportionally decreasing the cardiorespiratory endurance of Soldiers. Injuries can be expected to increase disproportionately with little additional fitness improvements if running is performed more than 3 times per week or if the amount of time spent running in a single session is greater than 30 minutes.

Table 5–2
Running duration, injuries, and cardiovascular endurance[1]

Duration (min/day)	Injury incidence (percent)	Change in cardiorespiratory endurance (percent maximal oxygen uptake)	Estimated change in 2-mile run time (minutes:sec)
0	0	0.7	-0:06
15	22	8.7	1:12
30	24	16.1	2:00
45	54	16.9	2:18
From 30 to 45 min/day	125% increase	5% greater	0:18 faster

Notes:
[1]Training: running 3 days/week, 85-90% MHR
[2]Adapted from Pollock ML, Gettman LR, Milesis CA, Bah MD, Durstine L, Johnson RB. Effects of frequency and duration of training on attrition and incidence of injury. *Med Sci Sports.* Spring 1977;9(1):31-36.

Table 5–3
Running frequency, injuries, and cardiovascular endurance[1]

Frequency (days/week)	Injury incidence (percent)	Change in cardiorespiratory endurance (percent maximal oxygen uptake)	Estimated change in 2-mile run time (minutes:sec)
0	0	-3.4	-0:30
1	0	8.3	1:06
3	12	12.9	1:48
5	39	17.4	2:24
From 3 to 5 days/wk	225% increase	35% greater	0:36 faster

Notes:
[1]Training: running 30 min, 85-90% MHR
[2]Adapted from Pollock ML, Gettman LR, Milesis CA, Bah MD, Durstine L, Johnson RB. Effects of frequency and duration of training on attrition and incidence of injury. *Med Sci Sports*. Spring 1977;9(1):31-36.

c. Exercise intensity and progression. The minimum threshold for PT required to achieve desired training effects has been less well characterized for Soldiers in operational units who have lost fitness due to lack of training. However, many studies among civilian populations suggest that cardiorespiratory fitness improvements require aerobic exercise at an intensity that produces heart rates between 55 and 90 percent of a person’s maximum heart rate. The lower end of this broad range is appropriate for initially low-fit individuals; those who have been training for a while can work at the higher end. Recommended minimum duration and frequency are 20 minutes, 2 to 3 times per week for individuals with initially low cardiorespiratory fitness levels. Recommended progression is gradual with small-increment increases in training stimulus over 4 to 6 months (table 5–4). Cardiorespiratory fitness can be improved by many activities other than running. Aerobic activities that provide alternatives to running include: graduated walking or marching, stair climbing, swimming, bicycling, cross-country skiing, rope-skipping, exercise to music, etc. However, Soldiers should do some running activity in order to pass the APFT since all forms of PT involve adaptations that are specific to the training mode.

d. Task-specific warm-up exercises. A prospective cluster randomized controlled trial demonstrated that warm-up exercises specifically designed for a single sport (team handball) significantly reduced musculoskeletal injuries in youth aged 15 to 17. Risk for all injuries combined and also for lower limb injuries in athletes who performed the task-specific warm-up exercises was only about half of the injury risk for control athletes who did their usual training. A separate cohort study of female soccer players aged 14 to 18 showed a 74 to 88 percent reduction in anterior cruciate ligament tears among players performing soccer-specific warm-up exercises over a 2-year follow up, compared to age- and skill-matched control athletes. No similar research has yet been conducted using this intervention with Soldiers.

Table 5–4
Example of aerobic training program progression for healthy, initially untrained adults

Program stage	Week	Exercise frequency (sessions/week)	Exercise intensity (%HR max[1])	Exercise duration[2] (minutes)
Initial Stage	1	2	55-60	15-20
	2	2	55-60	20-25
	3	3	60-70	20-25
	4	3	60-70	25-30
Improvement Stage	5-7	3-4	70-75	25-30
	8-10	3-4	70-75	25-30
	11-13	3-4	75-80	25-30
	14-16	3-5	75-80	25-30
Maintenance Stage	17+	3-5	75-85	25-30

Notes:
[1]HR max = 220 – age
[2]Although the limit of 30 minutes for novice exercisers is prudent to reduce injuries, most people who are conditioned after months of consistent exercise may be able to tolerate 30 to 45 minute exercise sessions without problems.
[3]Adapted from Franklin B, ed. *ACSM's Guidelines for Exercise Testing and Prescription.* 6 ed. Philadelphia: Lippincott Williams & Wilkins; 2000. ©Copyrighted. Wolters Kluwer. 2000. All Rights Reserved.

e. Wobble board (ankle disk) training. Rehabilitation of soccer players with ankle sprains using a wobble board for balance, coordination, and proprioceptive training has been shown to be effective in preventing subsequent ankle sprains in a randomized controlled trial. Some limited evidence from research with handball players and soccer players suggests that this training may also prevent ankle sprains and anterior cruciate ligament injuries in healthy athletes. No similar research has yet been conducted using this intervention with Soldiers.

f. Combined interventions. A number of programs have introduced multifaceted injury prevention interventions into military environments. Combining multiple interventions limits our ability to determine the effectiveness of individual interventions and thus isolate the most effective ones. However, combined strategies may be successful because different individuals respond to different aspects of the program, and because combining interventions may have a synergistic effect. At a minimum, combined intervention programs provide clues to effective strategies that can be investigated individually in future research. Findings from multiple studies of combined interventions demonstrate that overuse injuries can be considerably reduced and fitness improvement maintained with a well-designed PT program focused on injury prevention. Here again, the most prominent common finding is that reducing the amount of running in recruit training reduces injuries but still provides improvements in aerobic fitness. Several successful multiple-intervention programs are summarized in table 5–5.

Table 5–5
Published results of programs combining multiple interventions for reducing injuries associated with military physical training

Population studied	Combined interventions	Results
Female Australian recruits	1) Reduced foot marching speed from 7.5 km/h to 5 km/h (but no reduction in distance) 2) Allowed women to march at their own step length rather than marching in step 3) Encouraged marching and running in more widely spaced formations to aid in obstacle awareness 4) Conducted running on grass in preference to roads wherever possible 5) Substituted interval running for longer-distance runs where possible (thus reducing the total running distance)	Incidence of pelvic stress fractures reduced from 11.2% pre-intervention to 0.6% post-intervention
Australian military recruits (men and women)	1) Stopped running in formation 2) Introduced interval training (400 and 800 m sprints) on grassy surfaces 3) Reduced distance on the running test from 5 to 2.4 km 4) Standardized foot marches to include control of march speed, progressive load increments, and a prohibition on running 5) Ran in water as a cross-training technique	1) Compared to the pre-intervention cohort, injury rates post-intervention decreased 46% for men and 35% for women 2) Medical discharges decreased 41% among men but unexpectedly rose 58% for women
U.S. Army recruits in BCT (Victory Fitness Program)	1) No stretching prior to exercise 2) Wide variety of exercises (calisthenics, dumbbell drills, movement drills, interval training, long-distance running) compared to usual BCT PT program consisting of long distance running, stretching, calisthenics, sit-up and push-up practice 3) Ran a total of 17 miles compared to 38 miles in Control group 4) Highly prescriptive program providing progressive overload	1) Control group men and women (not performing the described program) were at 1.6 and 1.5 times respectively higher risk for overuse injuries than the experimental group 2) No group differences in traumatic injuries 3) Improvements in 2-mile run times were similar in the two groups

Population studied	Combined interventions	Results
		4) Overall APFT pass rate higher for Experimental group
U.S. Army recruits in AIT	1) Provided injury awareness education for organization leadership 2) Low level injury surveillance and follow-on discussion conducted by organization leadership 3) Introduced standard set of calisthenics 4) Reduced long-distance running; emphasized sprints instead 5) Enforced progressive overload	1) Adjusted relative risk of time-loss injuries was 46% lower for men and 58% lower for women trainees who experienced the interventions 2) Final physical fitness test scores similar in 2 groups
U.S. Army recruits in BCT (evaluation of the TRADOC standardized PT program)	1) No stretching prior to exercise 2) Wide variety of exercises (calisthenics, movement drills, climbing drills, interval training, long-distance running) compared to usual BCT PT program consisting of long distance running, stretching, calisthenics, sit-up and push-up practice 3) Ran less mileage than control group 4) Highly prescriptive program with enforced progressive overload	1) Experimental group men and women (performing the described program) were at 1.5 and 1.4 times respectively lower risk for overuse injuries than the experimental group 2) Overall APFT pass rate higher for experimental group

g. Stretching. For many years sports medicine professionals have recommended stretching prior to physical activity as a method for reducing the risk of injury. However, it was not until recently that the effectiveness of this intervention was tested. Studies performed to date generally show that stretching prior to or both prior to and after PT does not reduce the risk of injury. The few studies that did show an effect of stretching on injuries suffered from serious design flaws. However, studies failing to show stretching reduced injuries also suffer from limitations. Studies to date have not specifically targeted individuals with limited motion. Because epidemiological data indicate that both extremes of flexibility (too much or too little) are associated with increased injury rates, future stretching studies need to selectively target individuals with tight muscles and tendons to see whether stretching can reduce injuries for these Soldiers.

5–2. Modifications to equipment

a. Running shoes. Shoes worn during PT may be the most important equipment related to injury prevention. Soldiers in the U.S. Army have used running shoes instead of combat boots for PT since the early 1980s. Despite the relatively large number of studies on the biomechanics of running shoes and the hypothesized effects on injury reduction, data linking running shoes to actual cases of injuries are very sparse. The only study providing data for injuries and the age of running shoes showed a general trend of rising stress fracture incidence with older shoes, although the small group of subjects with the oldest shoes had no stress fractures (see figure 4–11). Investigators studying Israeli infantry recruit training reported foot overuse injury rates of 18 percent for those wearing high top basketball shoes compared to 34 percent for those wearing standard lightweight infantry boots. Some believe that running injuries might be reduced by matching specific running shoes to particular foot characteristics such as height of the longitudinal arch and foot/ankle flexibility. Running shoe manufacturers market running shoes in three categories: 1) stability, 2) cushioned, or 3) motion control. According to manufacturers, “stability” shoes are recommended for runners with normal arches, “cushioned” shoes for high arches and rigid feet, and “motion control” shoes for low arches and hypermobile feet. Army, Navy, and Air Force post and base exchanges and military clothing sales stores have adopted this nomenclature with a color-coded system: white for stability, blue for cushioned, and red for motion control. Effectiveness of shoe prescription according to this system has been tentatively supported by a single study that found injury rates to be reduced from 37 to 19 injuries/1000 Soldiers/month after shoes were prescribed post-wide on the basis of the colored system. However, this one study suffered from a number of problems, making it imperative that this intervention be tested in a randomized prospective prevention trial before conclusions are drawn regarding the effectiveness of customized shoe prescription.

b. Ankle braces. Ankle braces have been consistently demonstrated to reduce ankle injuries during high-risk activities such as basketball, soccer, and parachute landing falls. A systematic review employing meta-analysis methods pooling data from numerous studies estimates that the relative risk of ankle injury while wearing an ankle brace is only 53 percent of the injury risk without bracing. Among civilian athletes, the protection is greatest among those with previous ankle injuries, but remains significant for previously uninjured athletes. During airborne operations 30 to 60 percent of injuries involve the ankle. Well-controlled research has demonstrated that during U.S. Army airborne jump operations, those wearing an outside-the-boot brace had 0.6 ankle inversion injuries/1000 jumps compared to 3.8 injuries/1000 jumps for those who did not wear the brace. In an operational research study of rangers over a 3-year period, ankle injuries were three times higher among those not wearing braces. In spite of the demonstrated effectiveness of ankle braces in reducing ankle injuries among parachutists, this intervention was discontinued over concerns of cost. Once the brace was discontinued, hospitalizations for severe ankle injuries rose by 70 percent. This resulted in the reinstitution of the ankle brace for airborne operations in February 2005, and a central funding mechanism was established to pay for and replace the braces. Ankle braces are particularly appropriate for certain high-risk activities — especially for Soldiers with a history of previous ankle sprains.

c. Knee braces. A potentially promising study of a knee brace with a silicone ring to surround the patella showed that brace wearers were only 35 percent as likely as nonwearers to develop retropatellar pain syndrome during an intense 8-week progressive running program. Given the large prevalence of retropatellar pain syndrome among Army Soldiers, this intervention warrants additional scrutiny. However, given that only a single study has demonstrated this preventive benefit, these results must be considered preliminary until validated by additional research.

d. Shoe inserts. Shock-absorbing insoles in the boots of basic trainees give mixed results for reducing lower limb injuries overall but may be effective in reducing stress fractures. One systematic review employing meta-analysis methods pooling data from three studies estimates that shock-absorbing insoles reduce the number of stress fractures or stress reactions by over 50 percent. Computations derived from these methods suggest that for every 20 Soldiers wearing polyurethane or neoprene insoles, one stress fracture or stress reaction will be avoided. However, caution must be exercised in interpreting these results because the studies are few and have design flaws. Other similarly flawed studies have failed to demonstrate a reduction in stress fracture incidence with shock-absorbing insoles. Another systematic review of interventions for preventing shin splints concluded that the most encouraging current evidence favors the use of shock-absorbing insoles, but here again the serious flaws in reported studies prevent a recommendation for widespread insole use. Clearly, this is a potentially powerful intervention needing well-designed research to determine effectiveness.

e. Moisture-wicking socks. Although not strictly musculoskeletal injuries, foot blisters are among the most common injuries experienced by Soldiers and Marines. Blisters appear to be caused by friction between the skin and sock; that friction is exacerbated by moisture produced when sweating. Special socks designed to reduce foot moisture appear to reduce the likelihood of foot blisters. In Marine recruits undergoing 12 weeks of training, 39 percent of those wearing the standard U.S. military wool/cotton sock experienced blisters or cellulitis resulting in limited duty. Among those wearing a liner sock composed of polyester (thought to "wick" away moisture) worn with the standard sock, the foot friction injury rate was 16 percent. A third group of recruits had a comparable 17 percent injury rate while wearing the same polyester liner with a very thick wool/polyester blended sock designed to assist with the wicking action while reducing friction. Thus, both experimental sock systems were successful in reducing blisters. The commercial name for the liner sock is Coolmax® (Coolmax is a registered trademark of E.I. DuPont de Nemours, Inc., Wilmington, Delaware) but any sock composed of polyester will probably be effective.

f. Foot antiperspirants. Minimizing foot moisture through the use of emollient-free antiperspirants has been thought to reduce the incidence of foot blisters. A prospective double-blinded investigation examined foot blisters in U.S. Military Academy cadets who used either a placebo or an antiperspirant preparation (20 percent solution of aluminum chloride hexahydrate in a denatured ethyl alcohol base). Cadets were asked to apply the preparations to their feet for 5 consecutive evenings prior to a 21-km foot march. Cadets performed the march on a hot day and their feet were examined for blisters before and after. Although there was variable compliance with the 5-day application schedule, when groups were compared who had used the preparations for at least 3 days prior to the march, the antiperspirant group had a considerably lower blister incidence compared to the placebo (21 vs. 48 percent). However, 57 percent of those in the antiperspirant group experienced skin irritation (irritant dermatitis) compared to only 6 percent in the placebo group. The irritant dermatitis problem was also cited in another study suggesting this side effect needs to be addressed before this intervention can be widely recommended.

g. *Mouthguards*. Orofacial injuries are often caused by the same vigorous activities and exercises that can lead to musculoskeletal injuries. Mouthguards are mandated as essential protective equipment in such sports such as football, ice hockey, men's lacrosse, and boxing. The American Dental Association and the International Academy of Sports Dentistry currently recommend that mouthguards be used in 29 sport or exercise activities including acrobatics, basketball, bicycling, boxing, equestrian events, extreme sports, field events, field hockey, football, gymnastics, handball, ice hockey, inline skating, lacrosse, martial arts, racquetball, rugby, shotputting, skateboarding, skiing, skydiving, soccer, softball, squash, surfing, volleyball, water polo, weightlifting, and wrestling. Studies have compared mouthguard users and nonusers in many sports including football, rugby, basketball, and hockey. Despite the fact that there are study design problems in virtually all the investigations, most studies support the concept that mouthguards reduce or tend to reduce the incidence of orofacial injuries. Mouthguards have also been recommended to reduce the incidence of concussions but prospective cohort investigations show little difference in concussion incidence between mouthguard users and nonusers.

5–3. Other interventions purported to reduce training-related injuries

Authors of medical and sports literature recommend a host of additional interventions for preventing musculoskeletal injuries. Many of these recommendations are based on intuition or on logical inference from physiologic or biomechanical research, but have not been subjected to field studies to see whether they actually work. Future research may reveal that some of these interventions effectively prevent injuries, while others may be shown to be ineffective when studied rigorously. Among others, this category includes the following:

a. Soft, level surfaces for running; avoid running on concrete or asphalt.

b. Replace running shoes every 400 to 600 miles, when visibly worn, or every 6 to 9 months, whichever comes first.

c. Perform general (nonspecific) warm-up exercises prior to exercise or sport and allow cool-down afterwards.

d. Avoid specific exercises suspected of causing injury or aggravating existing injuries.

e. Strengthen specific muscle groups to prevent specific injuries.

f. Pre-participation medical screening to evaluate prior injuries or other factors that may increase the risk for injury.

g. Gradual retraining after joint injury/sprains to prevent recurrent sprains.

h. Athletic taping to prevent ankle injuries.

i. Education about injury causes and prevention.

j. Smoking cessation programs.

5–4. Summary of interventions by strength of evidence

a. Table 5–6 presents a summary of the interventions described above categorized by the strength of scientific evidence in favor of their effectiveness. Criteria for assigning interventions to specific categories and evaluations of specific studies yielding the classification assignments are outlined in appendix C.

Table 5–6
Strength of evidence favoring effectiveness for musculoskeletal injury prevention interventions

Strong evidence	Moderate evidence	Weak evidence
Reduction in running frequency, duration, and distance	Shock-absorbing insoles	Stretching
Ankle braces for high risk activities	Knee brace with patellar ring	Soft, level surfaces for running
Mouthguards	Wobble board (ankle disk) training	Replace running shoes every 400-600 miles, when visibly worn, or every 6 to 9 months
	Wicking socks to prevent blisters	General warm-up / cool-down
	Antiperspirants to prevent blisters[1]	Pre-participation screening
	Task-specific warm-up exercises	Individual prescription of running shoe based on foot type
		Ankle taping
		Targeted muscle strengthening
		Education to prevent injuries
		Smoking cessation programs

Note: [1]Potential for skin irritation

b. It is important to note that a lack of evidence for effectiveness is not the same as evidence that an intervention is not effective. The body of knowledge establishing evidence for effectiveness of injury prevention interventions for PT is relatively immature. Much research remains to be done in order to determine which potential interventions may effectively prevent injuries. It is likely that strong evidence may emerge from future research for interventions currently classified in lower categories.

c. Very little research has been performed to allow identification of subgroups of Soldiers who may have characteristics that make them more likely to benefit from specific injury prevention interventions. Future studies need to focus on development of multivariate prediction models that will allow characterization of individual Soldiers as likely or not likely to benefit from selected interventions. This is particularly relevant for interventions that may be expensive or inconvenient.

CHAPTER 6

MANAGEMENT OF SOLDIERS WITH MUSCULOSKELETAL INJURIES

6–1. First aid and self-care

a. Some musculoskeletal injuries will happen in spite of the best prevention efforts. Early symptoms and signs of musculoskeletal injuries may include pain, numbness, tingling, swelling, redness, loss of joint motion, weakness, deformity, or limping. The immediate goal in managing a musculoskeletal injury is to reduce pain, swelling, and inflammation and to remove or modify the injury-producing insult. Immediate first aid appropriate for most musculoskeletal injuries is the "RICE" protocol: rest, ice, compression, elevation. Anti-inflammatory medication may also be helpful in some injury cases. Physical profiles may be required to provide adequate recovery time and rest from ongoing physical training stressors.

b. Reducing physical activity will prevent further injury and allow the body sufficient time to proceed with its natural healing processes. The type and amount of activity reduction and the length of the rest period are determined by the type and severity of the injury. The initial rest period should be 1 to 2 days for minor injuries which allows enough time for the inflammation to diminish. More severe injuries, on the other hand, may require several days to weeks. For mild injuries (both chronic and acute), rest is relative, requiring only a decrease in the intensity, frequency, and duration of activity. In some cases, Soldiers may be able to exercise parts of the body that are not injured. For example, a Soldier with a leg injury can still perform exercise involving the arms. A good rule of thumb is that a Soldier can return to normal PT when the activity is relatively pain free and function is unimpaired (for example, full joint motion or no limping).

c. Ice will reduce swelling, inflammation, and pain. Ice placed directly over the injured tissue limits the amount of fluids going into the injured area, slows nerve conduction velocity, and serves as a topical analgesic. Ice is especially effective in the first 24 to 72 hours after injury onset. The simplest way to apply ice is to put it into a plastic bag. Place a damp towel over the injured area, with the ice pack placed over the towel and allow it to conform to the contours of the body. Soldiers should avoid placing dry towels or plastic directly on the skin because these can cause ice burns. Ice pack or bagged ice application should not exceed 20 minutes at a time. For acute injuries, a cold pack can be applied once every 2 to 3 hours for the first several hours. Later, ice can be applied twice per day. For chronic injuries, massaging with chunks of ice or ice frozen in paper cups can be effective when applied with slow circular strokes for 5 to 7 minutes two to three times per day.

d. Compression reduces internal bleeding and swelling of the affected area. Elastic wraps (for example, Ace bandages) can be used to minimize the acute swelling immediately following an injury and to reduce swelling in the first days following the injury. Care should be given to avoid applying the elastic wrap too tightly or allowing the elastic to roll or curl on the edges; either of these can impair circulation. Therefore, compressive wraps should be monitored to ensure circulation is not compromised. Elastic wraps should not be used over a moving joint when returning to full activity (for example, over the knee when running) because the wrap can easily roll up and impair circulation. Compression and ice can be combined by placing the ice over a damp elastic wrap.

e. Elevation reduces swelling and the entry of fluids into the affected area. The injured area ideally should be raised above the level of the heart (that is, mid chest). The injured body part should be placed in a comfortable position with cushioning or padding as required. Very gentle motion and/or activity can further enhance circulation and the removal of inflammatory products.

f. Nonsteroidal anti-inflammatory drugs (NSAIDs) can help reduce pain and inflammation. However, some evidence suggests these medications should be avoided during the early stage of injury recovery because they may interfere with healing processes. NSAIDs have been shown to delay bone healing after fracture; animal studies suggest NSAIDs may also delay soft tissue healing. These medications may therefore be best for chronic inflammatory conditions. For Soldiers with DOMS, NSAIDs offer no prophylactic or therapeutic benefit for strength or performance; a simple analgesic like acetaminophen is adequate for symptom control. Gastric irritation is the most common side effect of NSAIDs and can be diminished if the medications are taken with meals or if nonacetylated salicylates are used. Health care providers should be aware that anti-inflammatory effects from NSAIDs require higher doses than analgesic effects (table 6–1). Although analgesia will be effective within minutes to hours, the anti-inflammatory benefit from NSAIDs requires consistent dosing at anti-inflammatory doses for longer timeframes (typically a minimum of 10 to 14 days). Even though NSAIDs are common and available without prescription, they should not be given without monitoring by a physician for Soldiers with a history of peptic ulcer disease, renal disease, liver disease, hypertension, asthma or reactive airway disease, or for females who are pregnant or nursing mothers. Dehydrated or sodium-depleted Soldiers should not take NSAIDS because of potential renal complications. Soldiers taking certain other medications such as antacids or anticoagulants should not take NSAIDs because of undesirable interaction effects (table 6–2).

g. For blisters, treatment focuses on relieving pain, preventing the blister from enlarging, and avoiding infection. The best protection against infection is a blister's own skin. Small, intact blisters that don't interfere with function usually need no treatment. Larger or painful blisters that are intact should be drained without removing the skin. The blister should first be cleaned with an antibacterial agent and water. A straight pin or safety pin should be heated over a flame until the pin glows red, and then allowed to cool. After puncturing the blister with a small hole at the edge of the blister, the fluid is drained with gentle pressure, antibiotic ointment is applied, and the blister is then covered with a bandage that should be changed daily. If the top of the blister has torn off, the area should be kept clean, covered, and watched for signs of infection (pus draining from the blister, very red or warm skin around the blister, or red streaks leading away from the blister). If an infection occurs, medical care is required.

Table 6–1
Dosages of common oral nonsteroidal anti-inflammatory drugs (NSAIDs) according to desired effect

NSAID	Analgesia	Anti-inflammation
Aspirin (many trade names)	325 - 650 mg every 4 hr	3.6 - 5.4 g/day in divided doses
Diclofenac (Voltaren)	----	150 - 200 mg/day in 2 - 4 divided doses
Diflunisal (Dolobid)	1 g initially; 500 mg every 8 - 12 hr as needed	250 - 500- mg BID
Fenoprofen (Nalfon)	200 mg every 4 - 6 hr	300 - 600 mg TID or QID
Flurbiprofen (Ansaid)	----	200 - 300 mg/day in 2 - 4 divided doses
Ibuprofen (Advil, Amersol, Motrin, Nuprin, Rufen)	200 - 400 mg every 4 - 6 hr as needed	1.2 - 3.2 g/day in 3 - 4 divided doses
Indomethacin (Indameth; Indocin)	----	25 - 50 mg 2 - 4 times each day initially; can be increased up to 200 mg/day as tolerated
Ketoprofen (Orudis)	50 mg every 6 - 8 hr	150 - 300 mg/day in 3-4 divided doses
Meclofenamate (Meclofen, Meclomen)	50 mg every 4 - 6 hr	200 -400 mg/day 3 - 4 divided doses
Mefenamic acid (Ponstel)	500 mg initially; 250 mg every 6 hr as needed	----
Naproxen (Naprosyn)	500 mg initially; 250 mg every 6 - 8 hr	250, 375, or 500 mg BID
Naproxen sodium (Anaprox)	550 mg initially; 250 me every 6 - 8 hours	275 mg BID
Phenylbutazone (Butazolidin, Butazone)	----	300 - 600 mg/day in 3 - 4 divided doses initially; 100 mg 1 - 4 times each day for maintenance
Piroxicam (Feldene)	----	20 mg/day single dose; or 10 mg BID
Sulindac (Clinoril)	----	150 or 200 mg BID
Tolmetin (Tolectin)	----	400 mg TID initially; 600 mg-1.8 g/day in 3 - 4 divided doses

BID = twice per day; TID = three times per day; QID = 4 times per day.
Source: Ciccone CD: Pharmacology in Rehabilitation, 2nd edition. FA Davis, Philadelphia, 1996. (p. 205).

Table 6–2
Interactions of nonsteroidal anti-inflammatory drugs (NSAIDs) with other drugs[1]

Drug Combination	Effect	Management Options/Considerations
Oral anticoagulants with all NSAIDs	Increased oral warfarin activity Increased risk of bleeding (especially GI)	Monitor prothrombin time and for occult blood in stool and urine Avoid concurrent use of aspirin
Lithium with all NSAIDs	Increased steady state lithium concentration Lithium toxicity	Monitor lithium concentrations carefully Interactions less likely with aspirin than naproxen sodium or ibuprofen
Antihypertensive agents (beta-blockers, ACE inhibitors, vasodilators, diuretics) with several NSAIDs	Antihypertensive effect antagonized Hyperkalemia may occur with potassium-sparing diuretics and ACE inhibitors	Monitor blood pressure and cardiac function Monitor potassium concentration Low-dose aspirin (*e.g.*, 75 mg/day) may not interact with ACE inhibitor
Digoxin with NSAIDs	Renal clearance inhibited	Monitor digoxin concentrations Adjust dose as necessary
Valproate with aspirin	Oxidation of valproate inhibited Up to 30% reduction in clearance Possible valproate toxicity	Avoid aspirin with valproate Naproxen sodium is an alternative
Phenytoin with ibuprofen and high-dose salicylates	Increased phenytoin levels: phenytoin is displaced from serum protein binding sites, if phenytoin metabolism is saturated or folate concentrations are low	Monitor unbound phenytoin concentrations and adjust dose, if necessary Ensure patient has sufficient folate intake

Methotrexate with all NSAIDs	Reduced renal clearance Increased plasma methotrexate concentration	Avoid NSAIDs with high-dose methotrexate Monitor concentrations with concurrent therapy
Antacids (in high doses) with salicylates, aluminum hydroxide, and naproxen sodium	Salicylate concentrations possibly reduced by 25% Aluminum hydroxide decreases naproxen sodium absorption	Monitor clinical status Determine if salicylate dose needs to be increased
Probenecid with naproxen sodium	Reduced clearance of naproxen sodium	Monitor for adverse effects
H_2-blocking agents with salicylates, naproxen sodium	Potential salicylate toxicity Potentially reduced naproxen sodium effect	Monitor salicylate concentration Monitor clinical status
Corticosteroids with aspirin; salicylates (high doses)	Possible decreased salicylate effect due to increased clearance	Monitor salicylate concentration when changing corticosteroid dose
Insulin with salicylates	Possible decreased hypoglycemic effect with large salicylate doses	Monitor blood glucose
Sulfonylureas with salicylates (moderate to high-dose)	Hypoglycemic activity increased	Avoid concurrent use Monitor blood glucose concentrations when changing salicylate dose
Cephalosporins with aspirin	Possible increased bleeding risk	Avoid concurrent use
Aminoglycoside antibiotics and NSAIDs	Inhibits aminoglycoside renal clearance	Monitor antibiotic concentrations and adjust dose as needed

Source: Brooks PM. **Side-effects on non-steroidal anti-inflammatory drugs**. MJA 1988; 148: 248-251. ©Copyright 1998. *The Medical Journal of Australia* – reproduced with permission.

h. More serious injuries such as fractures, dislocations, or tendon and ligament ruptures require care from emergency medical personnel. Splinting or other immobilization of the affected area to avoid further injury is appropriate, but this should be performed by trained personnel. Litter or ambulance evacuation may be required.

6–2. Physical profiles/activity restrictions

a. Limitation of activity is often an important part of the health care management of Soldiers with musculoskeletal injuries. However, in addition to specifying what a Soldier should not do, health care providers should identify activities that are permissible given the nature of the injury.

b. Injuries can be characterized as mild, moderate, or severe. If a Soldier reports pain but has a normal initial clinical examination, the injury is probably mild. Injuries with bruising and/or swelling should be classified as moderate or severe, depending on the extent and severity of the clinical signs. Duration of physical profiles will typically range from 0 to 3 days for minor injuries, 1 to 2 weeks for moderate injuries, and greater than 2 weeks for severe injuries.

c. Physical profile writing will always require independent judgment of the health care provider who must weigh many factors in determining appropriate activity limitations. Specific limitations prescribed will be influenced not only by the nature and severity of the injury, but also by the duty assignment and operational setting of the Soldier. The selected limitations in table 6–3 are not prescriptive, but may offer general guidance on reasonable limitations and permissible activities for Soldiers with some of the most common musculoskeletal injuries.

6–3. Serious conditions that may mimic minor musculoskeletal injuries

a. Acute compartment syndrome is a surgical emergency. Although compartment syndromes have been reported in numerous anatomic locations, the most common site is the anterior compartment of the leg for young Soldiers engaged in running and marching. Increased intracompartmental pressure within a confined anatomic space causes ischemia and may result in neuromuscular necrosis. Potential additional serious complications include contractures, rhabdomyolysis, renal failure, and even death. Although fractures are the most common cause, contusions, muscle rupture, and even excessive exercise or prolonged marching (particularly over hilly terrain) can also result in acute compartment syndrome. Considering the seriousness of this injury and its potential complications, early diagnosis is imperative. The most important early symptom is pain out of proportion to the apparent severity of injury. Soldiers may complain of painful throbbing, tightness, aching, or pressure that is worse with palpation and stretching of the affected muscles. Health care providers should be suspicious anytime there is acute swelling, excessive pain, and muscle weakness with a history of trauma or overuse.

Table 6–3
Possible temporary physical profile limitations for common acute musculoskeletal injuries* (categories from DA Form 3349, Physical Profile, Dated February 2004)

1. Medical Condition (Injury)	Achilles Tendinopathy	Ankle Sprain	Femoral Neck Stress Fracture	Hip Flexor Tendinopathy/Strain	Low Back Pain	Metatarsal Stress Fracture	Pelvic Stress Fracture	Plantar Fasciitis	Retropatellar Pain Syndrome	Shin Splints	Shoulder Sprain/Strain	Tibial/Fibular Stress Fracture
2. Codes: none (Temporary)												
3. PULHES (Temp): variable, depends on severity of condition	L-2	L-2/3	L-3	L-2	L-2/3	L-2	L-3	L-2	L-2	L-2	L-2	L-3
4. Profile Type:	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp
5. Functional Activities												
Carry & fire individual weapon	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Move with fighting load at least 2 miles	Yes	No	No	Yes	No	No	No	Yes	No	Yes	No	No
Wear mask & all chem defense equipment	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Construct individual fighting position	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	No	No
3-5 second rushes under fire	Yes	No	No	Yes	No	No	No	Yes	Yes	Yes	Yes	No
Healthy without condition preventing deployment?	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes
6. APFT												
2 mile run	No	No	No	No	No	No	No	No	No	No	No	No
APFT Sit-ups	Yes	No	No	No	No	No	No	No	Yes	Yes	No	Yes
APFT Push ups	Yes	Yes	Yes	No	No	Yes	No	Yes	Yes	Yes	No	Yes
Alternate APFT Walk	No	No	No	No	Yes	No	No	No	Yes	No	Yes	No
Alternate APFT Swim	No	No	No	No	Yes	No	Yes	Yes	Yes	No	No	Yes
Alternate APFT Bicycle	No	No	No	No	Yes	No	Yes	Yes	No	No	Yes	No
7. Std. or Modified Aerobic Conditioning Activities												
Unlimited running	No	No	No	No	No	No	No	No	No	No	No	No
Unlimited walking	No	No	No	No	No	No	No	No	No	No	Yes	No
Unlimited biking	No	No	No	No	No	No	No	No	No	No	No	No
Unlimited swimming	No	No	No	No	No	No	No	No	No	No	No	No
Run at own pace/dist.	No	No	No	No	No	No	No	No	No	No	Yes	No
Walk at own pace/dist.	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bicycle own pace/dist.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
Swim at own pace/dist.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
8. Upper body wt tng	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes

1. Medical Condition (Injury)	Achilles Tendinopathy	Ankle Sprain	Femoral Neck Stress Fracture	Hip Flexor Tendinopathy/Strain	Low Back Pain	Metatarsal Stress Fracture	Pelvic Stress Fracture	Plantar Fasciitis	Retropatellar Pain Syndrome	Shin Splints	Shoulder Sprain/Strain	Tibial/Fibular Stress Fracture
9. Lower body wt tng	Yes	No	No	Yes	Yes	No	No	Yes	Yes	Yes	Yes	No
10. Other	1,2,3,13	1,4,5,6, 13, 14	1,6,7,8, 13, 14,15,16,17, 18,20	1,2, 13,14,16,18,19	1,7,8,13,16,19,20	1,5,6,9, 13, 14	1,6,7,8, 13, 14,16,18,19,20	1,2,3,13,14	1,2,3,13,18	1,2,3,13	1,10, 11,21,22	1,2,3,6, 12, 13,14,15
11. Optional Parameters												
Lift/carry max weight (pounds)	*	*	0	*	*	*	0	*	*	*	*	*
Lift/carry max distance	*	*	0	*	*	*	0	*	*	*	*	*
Run max distance	*	*	0	*	*	*	0	*	*	*	*	*
Standing max time	*	*	*	*	*	*	*	*	*	*	*	*
March max distance	*	*	0	*	*	*	0	*	*	*	*	*
Impact/jump max reps	*	*	0	*	*	*	0	*	*	*	*	*

Notes: * Recommendations vary according to severity of condition and individual needs.

[1] Attend Profiled Soldier Program
[2] Push-ups Unlimited
[3] Sit-ups Unlimited
[4] Allow ankle brace wear
[5] Allow injured leg over non-injured leg for push-ups
[6] Crutches
[7] Modified sit-ups / Crunches
[8] Modified push-ups
[9] Soft / hard shoe
[10] Allow arms across chest sit-ups
[11] Perform Nautilus strength training (No overhead press or incline press)
[12] Allow Soldier to cross sling or double sling carrying bag
[13] No run, no jump
[14] No march
[15] No rucksacking
[16] No flutterkicks
[17] No sit-ups
[18] No squats
[19] Sit-ups at own pace
[20] Push-ups at own pace
[21] No repetitive mid-chest to overhead activities
[22] No push-ups

b. Undiagnosed bone fractures can result in poor Soldier outcomes and greater readiness decrements. The Ottawa ankle, foot, and knee rules (figures 6–1 and 6–2) have been shown in multiple studies to have excellent diagnostic accuracy. All Soldiers complaining of knee, ankle, or foot pain and meeting these criteria should have radiographs taken to rule out fractures.

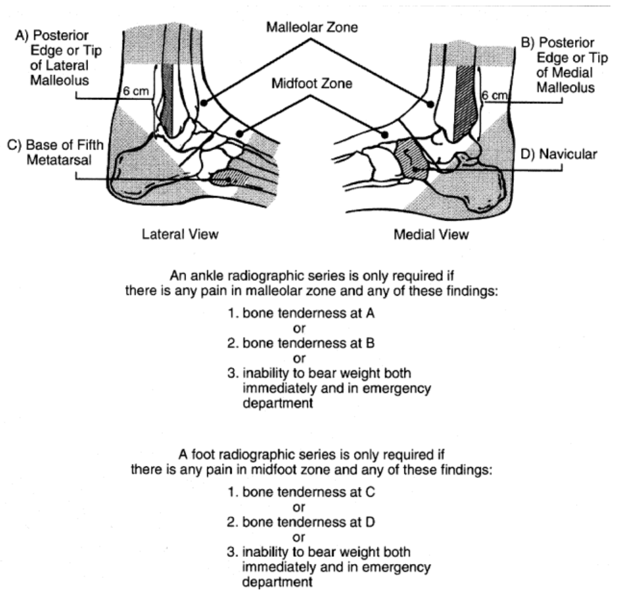

Figure 6–1. Ottawa ankle and foot rules for determining the need for radiography

Source: Stiell IG, McKnight RD, Greenberg GH, et al. Implementation of the Ottawa ankle rules. *JAMA.* Mar 16 1994;271(11):827-832. (figure 1). ©Copyrighted. 1994, *American Medical Assosciation*. All Rights Reserved.

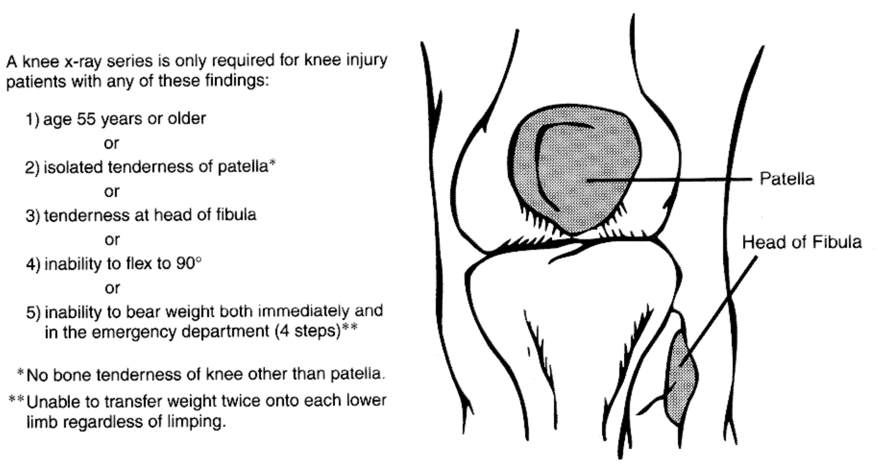

Figure 6–2. Ottawa knee rule for determining the need for radiography

Source: Stiell IG, Wells GA, Hoag RH, et al. Implementation of the Ottawa Knee Rule for the use of radiography in acute knee injuries. *JAMA.* Dec 17 1997;278(23):2075-2079. (figure 1). ©Copyrighted. 1997, *American Medical Association*. All Rights Reserved.

c. Stress fractures of the lower extremity may be confused with tendinopathy, shin splints, muscle strains or other relatively minor musculoskeletal problems. Bone stress injuries present as localized dull pain not associated with trauma that worsens during exercise or weight bearing. Localized swelling or periosteal thickening may occur at the pain site. Point tenderness to palpation typically is present at the injury site and is the hallmark of a stress fracture. Evidence of a fracture may never appear on plain radiographs or may not appear for 2 to 10 weeks after symptom onset. Nuclear bone scans are more sensitive than plain radiographs in the detection of stress fractures early in the clinical course but have a lower specificity. A focal "hot spot" is typically shown on the bone scan at the point of maximal tenderness. Magnetic resonance imaging scans are much better than plain films for initial diagnosis and may characterize the fracture better than bone scans.

d. Stress fractures of the femoral neck are medical emergencies. Femoral stress fractures are rare representing only 1 to 5 percent of all stress fractures. They are, however, extremely important because they are difficult to diagnose and have a high incidence of fracture nonunion, progression to complete displaced fractures, or avascular necrosis, all of which are avoidable catastrophes. In femoral stress fractures, patients usually complain of pain in the groin, anterior thigh, or knee, as well as painful range of motion of the hip. Any Soldier with history of overuse and walking with abnormal gait and complaining of groin pain or pain with hip motion should be examined by a health care professional to rule out a femoral stress fracture.

e. Joint injury can lead to joint instability and permanent disability if ligaments are ruptured or if less serious injuries are not treated adequately. Even with relatively minor joint sprains, tensile strength of ligaments will not return to normal until months after acute injuries. Initial management of sprains should emphasize accurate diagnosis and early use of the RICE protocol outlined above. More serious joint injuries should be suspected if joint effusion is immediate or severe, if the Soldier cannot bear weight on a lower extremity joint, or if the pain appears to be out of proportion to what is expected given the nature of the injury.

6–4. Physical training for injured Soldiers

a. Leaders should provide regularly scheduled PT programs for injured Soldiers who have physical profiles limiting their activities and preventing participation in unit PT. These programs provide alternative ways for Soldiers to engage in PT consistent with the physical limitations defined by their medical profiles.

b. Physical training programs for injured Soldiers should be conducted by unit leaders. Medical personnel should provide consultation and recommendations for permissible exercises that will not aggravate existing conditions or delay healing. Direct supervision of injured Soldier physical training by a physical therapist may be possible in units where these officers are assigned.

c. Field Manual 21-20 states, “Once the profile is lifted, the soldier must be given twice the time of the profile (but not more than 90 days) to train for the APFT.” Unit leaders should ensure that Soldiers with expiring profiles use this training period to restore fitness levels that may have deteriorated during the profile period.

d. Detailed recommendations for profiled Soldier PT programs are given in appendix D.

6–5. Medical surveillance for Soldier injuries

a. Unit leaders should develop and implement medical surveillance programs to track injuries and profiles with input as needed from medical personnel. The simplest unit-based injury surveillance system would document the number of injury profiles during a given interval of time (for example, week, month, or year) divided by the number of Soldiers or trainees in the unit during the specified time period. Every unit should have all the information needed for this basic level of surveillance. Rates can be calculated in an electronic spreadsheet or using a calculator. Ideally injury surveillance systems would document and report visits to battalion aid stations, troop medical clinics, specialty outpatient clinics, and hospital admissions. Incidence and severity of injuries should be documented along with the causes of injuries (for example, twisted ankle playing basketball or when fell from a truck). Numbers of days of limited and lost duty should be tallied and presented to commanders along with the rest of the data in easily accessible summaries in order to adequately target interventions. Unit-based surveillance systems should also track APFT scores and daily training activities. If injuries rise and APFT scores decline that is an indicator that a unit is overtraining. Medical surveillance data that tracks injuries at the installation level can be found on the Defense Medical Surveillance System Web site (http://amsa.army.mil/AMSA/amsa_home.htm) by accessing the Installation Reports.

b. A working example of a Soldier injury surveillance program was developed at the request of the TRADOC to track training-related injuries and to monitor the effectiveness of PT injury prevention programs at BCT installations. The U.S. Army Medical Surveillance Activity (AMSA) created the Training-Related Injury Report (TRIR) which is updated monthly with injury data from sites conducting BCT. These data are used to create summary reports for commanders. The program is described in greater detail in appendix D. Installation injury reports are also available from the AMSA Web site: http://amsa.army.mil/AMSA/amsa_home.htm. Two surveillance systems (medical- and company-based) are deployed at Aberdeen Proving Ground, Maryland, with the 61st Ordnance Brigade of the Army's Ordnance Center and School. These pilot programs have been developed for tracking and reporting of injuries to commanders at brigade, battalion, and company levels. Appendix E provides a description of these systems, the forms used, and the charts produced for commanders.

CHAPTER 7

MANAGING INJURY PREVENTION PROGRAMS

7–1. Elements of an injury prevention model

a. Fitness for duty is a readiness issue. Fitness for duty includes the prevention and management of injuries in each unit. Efforts to reduce musculoskeletal injuries in the Army will have the greatest chance for success if these efforts are coordinated as part of an overall systematic program. General Dennis J. Reimer, former Army Chief of Staff, has said: "Risk management is not an add-on feature to the decision-making process but rather a fully integrated element of planning and executing operations…" As stated in FM 5-19, Composite Risk Management (CRM) is the Army's primary decision-making process used to mitigate risks associated with all hazards that have the potential to injure personnel or otherwise impact mission readiness. As a guiding principle of CRM, Army leaders must not accept risk unless the potential gain or benefit outweighs the potential loss. The development and implementation of a comprehensive program will reduce the incidence, severity, and consequences of musculoskeletal injuries among Soldiers.

b. According to FM 5-19 and FM 101-5, the five steps of the CRM process are listed below. This CRM model is strikingly similar to the public health model of injury prevention that has yielded success in civilian settings to reduce motor vehicle accidents and traumatic brain injury among bicyclists.

(1) Identify hazards.
(2) Assess hazards to determine risks.
(3) Develop controls and make risk decisions.
(4) Implement controls.
(5) Supervise and evaluate.

7–2. Identifying hazards

a. Understanding the nature and extent of the problem is essential before remedies are considered. Injury problems in the Army must be considered in the context of Army culture and the specific nature of physical and other demands placed on Soldiers. Fortunately, a good deal of research has been published to help us understand the problem of musculoskeletal injuries in the military.

b. It is a leader's responsibility to identify hazards to the force with assistance from medical personnel where appropriate. Consider all aspects of current and future situations, environment, and known historical problem areas. Remember that hazards are not just slippery floors and electrical wires. Leaders must ask everyone to think of anything that could possibly be a factor in causing injury (for example, overtraining, physical training errors, improper lifting techniques, too frequent cadence calling, suggesting that Soldiers are substandard if they feel pain).

c. Musculoskeletal injuries may be defined by severity, setting, circumstances, body part, or by categories of Soldiers. Partners in injury prevention programs should agree on working definitions before other elements of the program are implemented.

7–3. Assessing hazards to determine risks

a. After identifying and defining the hazard, the probability and severity of the hazard needs to be determined in order to obtain a level of risk. Accurate metrics will allow commanders to make informed decisions about resource allocation, urgency of interventions, and impact of programs.

b. Measurements entail much more than counting the frequency of injuries. Ideally, incidence, severity, costs, readiness impact, and other factors should be quantified.

c. Five basic questions of epidemiology help define the factors that should be considered as possible contributors to musculoskeletal injuries: who, what, where, why, and how? Trends in injury occurrence (what type, when, where and how injuries are occurring) can sometimes be identified using overlay techniques — determine whether relationships exist between injury occurrence and unit training from the training calendar. Risk factors for musculoskeletal injuries in the Army have been fairly well characterized as summarized in chapter 4.

d. Key determinants are those factors that are important precursors of injury. It is important to consider not only those factors that predispose to injury, but also factors that may affect severity of the injury, duration, and final outcome of the injury.

7–4. Developing controls and making risk decisions

a. It is a leader's responsibility to develop control measures that eliminate the hazard or reduce its risk. A leader develops controls by asking questions such as: What is the post or command policy? What programs are offered from the local medical treatment facility that I can take advantage of? Are we in line with the U.S. Army Physical Fitness School doctrine? Who else may be involved? Who are my SMEs? What do my SMEs think could be done? Do my drill sergeants or NCOs think my controls can be realistically implemented?

b. Leaders should formulate strategies aimed at decreasing injuries. These strategies should be stated in the form of goals. For instance, a goal could be "no more than 15 percent of Soldiers in one cycle will sustain an injury for which they require a profile." However, leaders must also guard against unintended negative consequences of setting goals. For example, if a goal results in underreporting of injuries to meet the goal, no healthy purpose is served.

c. Not all risk factors are amenable to intervention. However, a careful analysis of identified risk factors will yield a list of modifiable factors that may be targeted for intervention.

d. One pitfall to avoid is selecting the easiest, cheapest, or most obvious intervention without carefully considering all possibilities. A generic list of injury prevention strategies with examples for prevention of musculoskeletal or other military injuries is presented in table 7–1.

Table 7–1
List of 10 generic injury prevention strategies with military examples

Strategy	Military examples
1. Prevent creation of the hazard.	Explosive ordnance disposal; reinforced fuel tanks
2. Reduce the amount of the hazard.	Reduce the amount of running in PT
3. Prevent release of the hazard.	Improved parachute designs; padding and spotters at obstacle courses; scheduling PT to avoid hottest time of day
4. Alter release of the hazard.	Seat belt use in all vehicles; ankle braces for high risk activities
5. Separate person and hazard in time and place.	Aircraft spacing, number of jumpers, spacing of jumps in airborne operations
6. Place barrier between the person and the hazard.	Body armor; armored vehicles
7. Modify basic qualities of the hazard.	Use of night vision goggles; reflective belts and vests for PT; improved footwear for running
8. Strengthen resistance to the hazard.	Balanced, progressive, and diversified PT program to improve strength, endurance, and mobility
9. Begin to counter damage done.	First aid, rapid professional medical response, medic availability; improvements in field evacuation
10. Stabilize, repair damage, and rehabilitate.	RICE protocol; limited weight bearing with crutches when needed; appropriate physical profiles

Adapted from Fowler, CJ. *Injury Prevention.* In McQuillan KA et al. (Ed.) *Trauma Nursing: From Resuscitation Through Rehabilitation.* 2001, 3rd Ed. Philadelphia: W.B. Saunders Company. ISBN 0721684416. (table 7–3, p.81).

e. Identifying possible interventions may generate a fairly long list of options. Each option should be evaluated for effectiveness, feasibility, cost, sustainability, acceptability, social will, and possible unintended consequences.

f. Consulting with all stakeholders in the command should precede selection of a course of action. Careful coordination will help ensure compliance with the proposed intervention.

7–5. Implementing controls

a. Proper planning will avoid many complications that can doom an intervention effort to failure. Leaders must consider and document the goals, objectives, actions, responsible personnel, methods, timelines, and metrics to be used.

b. Planners must ensure that targeted personnel will receive training in the proposed intervention. Command support must be clear and prominent in all presentations. Soldiers tasked to implement the interventions must be empowered to make the necessary changes. Consideration must be given to methods that will help Soldiers perceive benefits from participation in new or altered initiatives. Periodic reinforcement by commanders will be needed to maintain new injury prevention measures.

7–6. Supervising and evaluating

a. Supervision and evaluation must occur throughout all phases of any operation or activity. This continuous process provides the ability to identify weaknesses and to make changes or adjustments to controls based on performance, changing situations, conditions, or events. The effectiveness of interventions should be evaluated at the time the interventions are planned. Outcome variables identified as the most relevant metrics must be measured at baseline and measured again at some reasonable future point in order to demonstrate whether or not change has occurred.

b. Evaluation results should be provided to commanders and shared with Soldiers. An on-going surveillance system allows not only for evaluation of newly implemented prevention strategies but also permits long-term monitoring of existing interventions. Effective interventions will be supported and maintained; ineffective interventions will be modified or terminated.

7–7. The Command Injury Prevention Council

a. The Command Injury Prevention Council (CIPC) is an intra-Army, intra-command committee established according to AR 15-1 requirements. The CIPC is responsible for implementing injury prevention at the battalion level through the use of a team of leaders who systematically perform the work of the Council.

b. The purpose of the CIPC is to advise the commander on methods to reduce and/or maintain an acceptable level of musculoskeletal injuries and lost duty time within the battalion. This is accomplished by identifying injury trends and causative factors and by recommending, implementing, and evaluating targeted injury prevention interventions. It is in the CIPC where injury hazards are discussed, ideas are generated, controls implemented, and interventions evaluated.

c. Command leadership will establish a CIPC in their units to:

(1) Identify risk factors for injury and solutions to eradicate or reduce those risk factors.
(2) Assist companies to accurately track injuries and identify injury trends.
(3) Enact the commander’s guidance on injury prevention and fitness.
(4) Share information on approaches to prevention.

(5) Evaluate the effectiveness of implemented guidance and make change recommendations as necessary.

d. The composition of the CIPC is as follows:

(1) The CIPC is chaired by one of the company commanders demonstrating knowledge in injury prevention, fitness, and nutrition: a dynamic leader with good organizational and communication skills who is able to motivate others.

(2) Council members include all company commanders, one senior drill sergeant per company, and the battalion training NCO and S-3.

(3) Subject matter experts may be invited to attend Council meetings based on their expertise in the field of musculoskeletal injury (generally physical therapists, occupational therapists, preventive medicine doctors, and physician assistants).

(4) Guest members may attend upon invitation (Morale, Welfare, & Recreation representatives, dieticians, community health nurses, chaplains, etc).

e. The CIPC will generally meet monthly, for approximately 1 to 2 hours.

f. Continuance of the CIPC will be evaluated and justified every 2 years according to AR 15-1 or other relevant guidance.

Appendix A
References

Section I
Required Publications

Department of the Army Pamphlets can be found at http://www.army.mil/usapa/epubs/index.html.

AR 15-1
Committee Management

AR 40-501
Standards of Medial Fitness

AR 350-1
Army Training and Education

DA Pam 611-21
Military Occupational Classification and Structure

Field Manual 5-19
Composite Risk Management (draft)

Field Manual 21-18
Foot Marches

Field Manual 21-20
Physical Fitness Training

Field Manual 101-5
Staff Organization & Operations

TB MED 507
Heat Stress Control and Heat Casually Management

Section II
Related Publications

A related publication is a source of additional information. The user does not have to read it to understand this bulletin.

TRADOC Regulation 350-6
Training: Enlisted Initial Entry Training (IET) Policies and Administration

U.S. Army Research Institute of Environmental Medicine Technical Report No. TN 00-3: Injury Control Part I: Understanding Injuries in the Military Environment

U.S. Army Research Institute of Environmental Medicine Technical Report No. TN 00-4: Injury Control Part II: Strategies for Prevention

U.S. Army Center for Health Promotion and Preventive Medicine Project No. 12-HF-5772A-03: Guidance for ability group run speeds and distances in basic combat training

U.S. Army Center for Health Promotion and Preventive Medicine Technical Information Paper No. 12-001-0203: Recommendations for PT-related injury prevention policies and practices to reduce injuries and improve physical performance in initial entry training

U.S. Army Training and Doctrine Command IET Standardized Physical Training Guide

Standardized Physical Training Video: PT Execution, PIN 711735/DVD22-04

Standardized Physical Training Video: Warm-up and Cool-down, PIN 711736/DVD22-05

Standardized Physical Training Video: Strength and Mobility Activities, PIN 711737/DVD22-06

Standardized Physical Training Video: Endurance and Mobility Activities, PIN 711738/DVD22-07

Section III
Prescribed Forms

This section contains no entries.

Section IV
Related Forms

DA Form 3349
Physical Profile

Appendix B
Open Literature

Peer-reviewed journal articles cited below (*journal names in italics*) can be obtained through a medical librarian. Abstracts and, in some cases, full-text articles are available at PubMed online: http://www.ncbi.nlm.nih.gov/entrez/query.fcgi. Cochrane systematic reviews may also be obtained through a medical librarian. Abstracts of Cochrane systematic reviews are available online: http://www.thecochranelibrary.com/. The cited U.S. Army War College publication can be accessed online: https://apfri.carlisle.army.mil/web/Publications/Redbook.htm. Medical Surveillance Monthly Reports can be accessed online: http://amsa.army.mil/AMSA/amsa_home.htm. Technical reports from the U.S. Army Research Institute of Environmental Medicine and from the U.S. Army Center for Health Promotion and Preventive Medicine may be obtained by downloading from the Scientific & Technical Information Network: stinet.dtic.mil/str/guided-tr.html.

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B-5. Injury database publications

The following are bibliography entries relative to databases containing information about injuries.

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b. Lauder TD, Baker SP, Smith GS, Lincoln AE. Sports and physical training injury hospitalizations in the army. *Am J Prev Med.* Apr 2000;18(3 Suppl):118-128.

c. Smith GS, Dannenberg AL, Amoroso PJ. Hospitalization due to injuries in the military. Evaluation of current data and recommendations on their use for injury prevention. *Am J Prev Med.* Apr 2000;18(3 Suppl):41-53.

d. Songer TJ, LaPorte RE. Disabilities due to injury in the military. *Am J Prev Med.* Apr 2000;18(3 Suppl):33-40.

B-6. Injury physiology publications

The following are bibliography entries relative to the physiology of injuries.

a. Paavola M, Kannus P, Jarvinen TA, Khan K, Jozsa L, Jarvinen M. Achilles tendinopathy. *J Bone Joint Surg Am.* Nov 2002;84-A(11):2062-2076.

b. Sanderlin BW, Raspa RF. Common stress fractures. *Am Fam Physician.* Oct 15 2003;68(8):1527-1532.

Appendix C

Classification of Injury Prevention Interventions by Strength of Evidence

C–1. The classification scheme used to categorize strength of evidence for efficacy of preventive interventions is provided below in table C-1. Levels of evidence with associated descriptions are presented and grouped broadly into categories of strong evidence, moderate evidence, and weak evidence.

Table C-1
Levels of evidence for efficacy of interventions

Strong evidence		Moderate evidence		Weak evidence	
Level	**Description**	**Level**	**Description**	**Level**	**Description**
1a	systematic review(s) of multiple randomized controlled trials with homogeneity of directions and degrees of results	***2a***	systematic review(s) of multiple randomized controlled trials with worrisome heterogeneity of directions and degrees of results	***3a***	systematic review(s) of multiple case-control studies with or without homogeneity of directions and degrees of results
1b	individual randomized controlled trial(s) with good protections against validity threats and narrow confidence intervals	***2b***	systematic review(s) of multiple cohort studies with homogeneity of directions and degrees of results	***3b***	systematic review(s) of multiple cohort studies with worrisome heterogeneity of directions and degrees of results
		2c	individual randomized controlled trial(s) but flawed with validity threats or wide confidence intervals	***3c***	individual case-control study
		2d	individual cohort study	***3d***	poor-quality cohort and case-control studies
		2e	individual single-group time-series study	***3e***	individual case study or case series
				3f	study of multiple interventions applied simultaneously
				3g	unpublished report or abstract from professional meeting presentation
				3h	physiologic, biomechanical, attitudinal, or cognitive research
				3i	expert opinion without research evidence

Scheme adapted from: Centre for Evidence-Based Medicine. *Levels of Evidence and Grades of Recommendation*. http://www.cebm.net/levels_of_evidence.asp. Accessed 01 December 2005.

C–2. Specific studies and other documents that were evaluated for strength of evidence based on the classification scheme above are presented below in table C-2. These evaluations yielded the rankings of interventions in table 5-6 in chapter 5 of this document.

Table C–2
Strength of intervention evidence with associated references and levels of evidence.

	Interventions	References[a] (Levels of Evidence[b])
Strong Evidence	Reduction in running frequency, duration, and distance	Yeung 2001 (1a)↑, Andrish 1974 (2c)↑, Pollock 1977 (2c)↑, Rudzki 1997 (2c)↑, Knapik 2004 (3f)↑, Shaffer 1996 (3g)↑
	Ankle braces for high risk activities	Handoll 2001 (1a)↑, Amoroso 1998 (2c)↑, Sitler 1994 (2c)↑, Surve 1994 (2c)↑, Tropp 1985 (2c)↑
	Mouthguards	Finch 2005 (2c)↑,Quarrie 2005 (2e), LaBella 2002 (2d)↑, Marshall 2005 (2d)↑, Maestrello-DeMoya 1989 (2d)↑ (2e)↑, Jolly 1996 (3c)↑, Hickey 1967 (3h)↑, Stenger 1964 (3h)↑, Chapman 1985 (3i)*, Blignaut 1987 (3d)↓
Moderate Evidence	Shock-absorbing insoles	Gillespie 2000 (2a)↑, Yeung 2001 (2a)↓, Andrish 1974 (2c)↓, Gardner (2c)↓, 1988 Milgrom 1985 (2c)↑, Schwellnus 1990 (2c)↑, Sherman 1996 (2c)↓, Smith 1985 (2c)↑, Bensel 1986 (3g)↓, Williams 1998 (3g)↓
	Knee brace with patellar ring	BenGal 1997 (2c)↑
	Wobble board (ankle disk) training	Tropp 1985 (2c)↑, Caraffa 1996 (2c)↑, Wedderkopp 2003 (2c)↑, Sheth 1997 (3h)↑
	Wicking socks to prevent blisters	Herring 1990 (2c) ↑, Knapik 1996 ()↑
	Antiperspirants to prevent blisters	Knapik 1998 (2c)↑, Reynolds 1995 (2c)↓, Darrigrand 1992 (2e)↓
	Task-specific warm-up	Olsen 2005 (2c) ↑,Mandelbaum (2d)↑
Weak Evidence	Stretching	Pope 2000 (1b)↓,Thacker 2004 (2a)↓, Andrish 1974 (2c)↓, Pope 1998 (2c)↓, Bixler 1992 (3d)↑, Cross 1999 (3d)↓, Hartig 1999 (3d)↑, Van Mechelen 1993 (3f)↓, ACSM, 2003 (3i)*, FM 21-20 1992 (3i)*, Kovaleski 2001 (3i)*, Levy 1993 (3i)*, Shamus 2001 (3i)*
	Soft, level surfaces for running	Dixon 2000 (3h)↑, FM 21-20 1992 (3i)*
	Replace running shoes every 400-600 miles, when visibly worn, or every 6 to 9 months,	Gardner 1988 (3c) ↑, Burgess 1985 (3e)↑, Cook 1985 (3h)↑, Lowe 1998 (3i)*
	General warm-up / Cool-down	Van Mechelen 1993 (3f)↓, FM 21-20 1992 (3i)*, Franklin 2000 (3i)*, Kovaleski 2001 (3i)*, Levy 1993 (3i)*, Shamus 2001 (3i)*
	Pre-participation screening	Kovaleski 2001 (3i)*, Rayson 2000 (3g)↑
	Individual prescription of running shoe based on foot type	Knapik 2001 (3d)↑, Wilk 2000 (3e)↑, FM 21-20 1992 (3i)*
	Ankle Taping	Handoll 2001 (2a)↓, Verhagen 2000 (3a)↑, Garrick 1973 (3d)↑, Rovere 1988 (3d)↓, Ekstrand 1983 (3f)↑
	Targeted muscle strengthening	Askling 2003 (2c)↑, FM 21-20 1992 (3i)*, Levy 1993 (3i)*, Shamus 2001 (3i)*
	Education to prevent injuries	Knapik 2002 (3f)↑, Ekstrand 1983 (3f)↑, Elliott 2002 (3h)↑, Woodruff 1994 (3h)↑
	Smoking cessation programs	Gilchrist 2000 (3i)*

[a]First author name only: see appendix B for full citation.
[b]Levels of evidence according to the criteria categorized above
↑Results favored efficacy of the intervention
↓Results did not favor efficacy of the intervention
*No results presented but expert opinion favors the intervention

Appendix D

Commander's, Senior NCO's, and Instructor's Guide to Control of Musculoskeletal Injuries Associated With Physical Training

D–1. Introduction

a. The unit commander is the critical agent for injury control intervention. Effective command emphasis on injury prevention must be based on an understanding of how Soldiers are injured and which interventions are appropriate. In order to protect the health of the Soldiers under his or her command, a unit commander must have accurate and timely feedback on the injury status, be familiar with general mechanisms of injury and possible preventive interventions, and be familiar with the use of the CRM process as applied to musculoskeletal injuries to minimize injury occurrence and exposure to risk during PT, field exercises, garrison activities or during off-duty recreation.

b. Soldiers will never operate in a risk-free environment; however, a commander should decrease the risk of injury wherever possible. A unit commander is supported by medical expertise in his or her efforts to ensure the health of his or her troops and their combat readiness. Local medical support personnel must participate in this CRM process for injury prevention. Conserving combat power is achieved by introducing CRM (FM 5-19) into everyday training and activities.

c. The TRADOC IET SPT Guide was implemented to minimize injuries associated with PT in the IET environment. Proper execution of these programs has been shown in two controlled studies to reduce injuries and to improve APFT pass rates. The need for commanders to monitor injury rates will continue under this new program. Establishing baseline injury rates and tracking changes over time will assist leaders in monitoring compliance with the prescribed programs and in evaluating the effectiveness of the programs.

d. Although the specific recommendations in this appendix are often focused on IET Soldiers, the principles underlying the recommendations are universal.

D–2. Surveillance: Training-Related Injury Report

a. Injuries are the greatest health risk and obstacle to Soldier combat readiness. This is especially true for BCT. Because clinic visits and injury rates are so high in BCT, the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) has developed a metric for tracking and reporting training-related injury rates in BCT as a method to monitor the effectiveness of injury prevention programs.

b. The TRIR was initiated by AMSA to track training-related injuries. Calculating training injury rates requires the following data:

(1) The number of training injury cases receiving medical treatment (the numerator) from the BCT units at each of the five Army Training Centers (ATCs).

(2) The total number of trainees engaged in BCT by installation (the denominator or population at risk).

c. The AMSA has developed operational case definitions for training-related injuries of the lower extremity such as stress fractures, overuse knee pain, and tendinopathy. TRADOC provides monthly personnel data on all trainees. Cases identified in the medical records system by ICD-9 diagnostic codes are linked with the personnel data from TRADOC to produce installation-specific rates.

d. After merging the injury and personnel data, AMSA calculates training-related injury rates and provides a monthly report to the TRADOC Surgeon. Depending upon the currency of unit-specific personnel data from TRADOC, these reports can be produced more frequently to provide commanders with bimonthly or weekly rates down to the company level.

D–3. Surveillance: Company-level master APFT and profile tracking and reporting system

a. Currently, there is no standardized means of tracking and reporting APFT scores, injury-related profiles, limited duty days, or causes of injuries. The TRIR is a metric for BCT commanders to follow trends of injury rates, but it does not allow commanders to detect which activities are causing injuries, which Soldiers are experiencing the injuries, or the relationship between injuries and physical performance. A master APFT and profile tracking system at the company level can provide greater visibility of physical performance and training-related injuries, strengthen local command decision-making and management of trainees on a day-to-day basis, and permit commanders, cadre, and SMEs to evaluate the success of targeted injury prevention interventions.

b. Physical performance tracking should include trainee demographics (such as name, social security number, age, and unit identification code), raw scores for all three APFT events, and APFT pass/fail status. Suggested elements of profile tracking include the location of injury (body part), type of injury (traumatic or overuse), associated activity, medical diagnosis, activity restrictions, and profile length.

D–4. Education

a. Battalion surgeons are responsible for first echelon preventive medicine education and unit support. They must understand and be able to teach basic CRM, injury surveillance, injury risk factors, and effective interventions.

b. Commanders are responsible for the health and welfare of their Soldiers. They must also understand basic CRM, injury surveillance, injury risk factors, and effective interventions.

c. Injury control education materials are available from USACHPPM for instructional use in units (http://chppm-www.apgea.army.mil/deds/InjPrev.aspx). Slides and other resource materials are provided for familiarization with the basics of CRM as it applies to injury control. The education package contains five modules: Introduction, Physical Training, Contributing Factors to Injury, Work Tasks and Equipment, and Injury Control Management. Module contents include:

(1) *Introduction*: discussion of course objectives, defining the issues and costs for the military, and changing the culture to ensure optimal physical performance while simultaneously reducing injuries.

(2) *Physical training*: the patterns of PT injury; a review of the medical literature on fitness, physical activity, and high volume running; an overview of exercise; and recommendation for preventive interventions.

(3) *Contributing factors to injury*: anatomical variations that increase risk of injury, modifiable risk factors, and the role of leadership.

(4) *Work tasks and equipment*: basic principles of worksite safety, applied ergonomics, and equipment selection and use.

(5) *Injury control management*: the CRM process as a model (Identify Hazards, Assess Hazards, Make Decisions, Implement Controls, Supervise and Evaluate), suggestions for tracking and managing injuries, and a practical exercise using the model.

D–5. Physical training injury reduction during Army IET

a. Implementation of TRADOC's IET SPT Guide was a direct measure to control injury while ensuring performance goals are achieved in IET. Physical training strategies, prescriptions, and practices to reduce injuries were incorporated into every aspect of the training program. Most of the guidance is consistent with the principles taught in FM 21-20. Some of the guidance is based on more current and relevant research that supersedes FM 21-20 guidance. The IET SPT Guide can be accessed online (https://www.infantry.army.mil/usapfs/doctrine.htm). Certain principles of PT specifically focused on injury prevention are emphasized to reinforce the application of sound training guidance throughout IET.

(1) De-emphasize distance running.

(a) Emphasize ability groups and interval training to hasten the conditioning of speed and stamina required for all trainees while reducing injury risk.

(b) Do not use running for an activity during PT on consecutive days.

(c) Treat foot marches over 3 kilometers as if they are running activities.

(d) Strictly enforce heat injury prevention work/rest ratios per TB MED 507. Because the risk of musculoskeletal injury rises with higher environmental temperatures, following the work/rest guidelines will reduce the risk of both heat injury and musculoskeletal injury.

(e) Employ a standardized, gradual, systematic progression of running in IET. Two schedules for progressive ability group running regimens have been recommended. The running program outlined in table D–1 was based on published research involving actual run time performances from over 28,000 BCT recruits. A more aggressive program was adopted for use in the IET SPT Guide (figure 6-3 in that document). Similar standardized, gradual, systematic progression of running should also be utilized in one station unit training (OSUT) and AIT.

(f) For trainees in the two of four lowest ability running groups, do not exceed **25 miles** for the total amount of running during BCT (including ability group running, unit running, interval running, and agility running).

(g) Rebuild fitness gradually for trainees who miss more than 1 week of PT (such as those returning from Exodus, new-starts to units, or those coming off profile). Expecting trainees to immediately return to the running volume achieved before training was interrupted overloads their capacity inasmuch as some detraining has occurred.

Table D–1
Progressive ability group run (AGR) schedule based on performance of trainees in BCT[1]

Training week	Ability group[2]	Distance (miles)	Pace (min/mile)	Total run time (min)
1	A (fast)	2.0	8.0	16
	B	1.7	9.0	15
	C	1.0	10.5	10
	D (slow)	0.8	12.0	10
2	A	2.0	7.5	15
	B	1.8	8.5	15
	C	1.2	10.0	12
	D	1.1	11.0	12
3	A	2.7	7.5	20
	B	2.4	8.5	20
	C	1.4	9.5	14
	D	1.3	10.5	14
4	A	2.7	7.5	20
	B	2.4	8.5	20
	C	1.7	9.5	16
	D	1.6	10.0	16
5	A	2.8	7.25	20
	B	2.5	8.0	20
	C	2.0	9.0	18
	D	1.9	10.0	18
6	A	3.4	7.25	25
	B	3.1	8.0	25
	C	2.4	8.5	20
	D	2.1	9.5	20
7	A	3.4	7.25	25
	B	3.1	8.0	25
	C	2.4	8.25	20
	D	2.1	9.5	20
8/9	A	4.1	7.25	30
	B	3.8	8.0	30
	C	2.4	8.25	20
	D	2.2	9.0	20

Notes:
[1]This program is based on 7 criteria: 1) minimizing injuries, 2) the initial fitness level (VO_2max) of recruits, 3) historical improvements in run times during BCT, 4) running speeds of the slower individuals in each ability group, 5) running speeds that must be achieved to "pass" the APFT 2-mile run in BCT, 6) the gender composition of the ability groups, and 7) recommendations from the trainers.
[2]Ability group A represents the fastest group, and ability group D represents the slowest group as measured by 1- or 2-mile run times. Groups are determined in such a way that over time, roughly 25 percent of Soldiers will fit into each group.

(2) Balance the PT program to prevent overtraining.

(a) The traditional overemphasis on PT as preparation for the APFT is a recipe for eliminating balance and diversity in the PT program. Many alternatives to traditional middle-distance to long-distance running are available that will provide adequate stimuli for cardiorespiratory fitness and improved endurance. Effective endurance exercises use large muscle groups for body movements that are rhythmic or dynamic in nature. Similarly, many muscle strength and endurance exercises are available as alternate choices to push-ups and sit-ups.

(b) The IET SPT Guide includes core body management skills training, more strength conditioning, and more agility conditioning to evenly distribute musculoskeletal stresses across the body. This reduces injury risk to the lower extremity and increases the likelihood of improved military occupational task performance. Physical training balances cardiovascular endurance with strength and mobility by providing strength and mobility conditioning on alternate days from running. So-called “cross training” is a standard training technique in the athletic world that permits more conditioning activity without overtraining one particular muscle group or system. Consistent adherence to a more balanced and standardized approach to PT will maximize PT time and develop the optimal combination of strength, mobility, and endurance in future warfighters.

(c) Consider near-maximal or exhaustive military training (including, but not limited to strenuous foot marching, conditioning obstacle courses, and bayonet assault courses) as the equivalent of a heavy PT session. If any PT sessions are conducted on days of heavy or exhaustive military training, activities should be limited to warm-up type activities. Physical training sessions conducted the day before and the day after heavy military training should be light (of limited duration and intensity) and should be focused on body systems not stressed on adjacent days.

(d) When planning the PT schedule, consider the number of miles logged by units who are required to foot march great distances to and from training sites.

(e) Perform low-intensity, task-specific, dynamic warm-up activities prior to more intense training in preference to stretching exercises. For example, before any intense intervals or ability group running, cadre will lead a warm-up that includes calisthenics and a form running drill to prepare body systems for the more vigorous activity. Several research studies indicate that pre-exercise stretching does not provide a protective effect against injury. Run performance is enhanced by leading trainees through the same task-specific, dynamic warm-up activities before each administration of the APFT.

(f) Discourage formation running and cadence calls while running. Running is more efficient when each trainee can run at his or her own stride length. Doing so may reduce risk of serious injury for the shortest and tallest trainees since cadence calling forces all trainees to move at the speed and stride length of the caller. Cadence calls can likely be used for short-distance foot marches with less potential for harm than when used with distance running.

(g) Eliminate remedial PT programs that involve extra long training or more than one exercise session per day. Trainees exhibiting low physical performance and who sustain injuries or severe muscle soreness are likely suffering from overtraining syndrome – a condition for which more exercise is counterproductive. Overtraining hurts Olympic athletes, recreational athletes, and Army trainees alike. Those engaged in any PT that routinely exceeds their ability to recover from day to day can expect to experience lowered physical performance and more injuries. Adding more musculoskeletal stress through additional PT sessions for such individuals increases their risk of injury without improving physical fitness or performance.

(h) Allowing adequate recovery reduces injury risk and increases physical performance. The prescription for those trainees of lower physical performance may include more recovery rather than more exercise to improve. Running and strenuous foot marching should not occur more than three (nonconsecutive) times per week. The IET SPT program, conducted 4 to 6 days per week, balances heavy and light training days without overtraining. Exhaustive or near-maximal military training should take the place of a PT session for that day. Planners should use the schedules provided in the IET SPT Guide as a management tool to offset PT and military training physical demands.

(i) The psychological and motivational aspects of overtraining (such as increased fatigue, depression, loss of sleep and appetite, reduced concentration, and lack of motivation) are likely contributors to other reasons for attrition in IET. Although it may seem paradoxical, for trainees who are overtrained, decreasing the amount or intensity of training can increase their physical performance and reduce their risk of injury while it may reduce attrition as well.

(j) Do not use PT as a punitive, corrective, or disciplinary tool. This practice causes excessive training overload and leads to overtraining and injuries due to its unpredictable frequency and volume. Punitive PT is counterproductive from the physical performance and injury perspective. The end result will likely be reduced readiness because of an increased injury risk and decreased physical performance.

(3) Ensure command responsibility for injuries as well as physical performance.

(a) Commanders should assume responsibility and be held accountable for all the outcomes of PT programs conducted in their units. Physical fitness test scores are only one outcome of PT; injury rates are another equally important outcome. The predominant types of injuries seen in IET and in the operational Army occur most frequently in association with vigorous PT or exercise. Unit injury rates provide another important measure of the success or failure of unit PT. Therefore, commanders should focus on APFT pass rates and injury rates as the best composite assessment of PT program effectiveness and modify their PT program as needed to reduce injuries; thereby improving performance and readiness.

(b) Place more emphasis on the percent of trainees passing the APFT rather than the highest average unit score when measuring unit success on the APFT. The custom of achieving the highest unit average APFT score may cause commanders and cadre to push the least fit trainees to overreach their capability. Pushing the least fit trainees beyond their capacity to recover has two potentially detrimental effects — greater risk of injury and diminished physical performance — two cardinal signs of overtraining syndrome.

(c) Use unit injury rates as a barometer of PT program success or failure just as is done with APFT scores. Since the PT program is the primary cause of injuries seen in both IET and the operational Army, high injury rates indicate failures of that program. Installation and unit commanders can establish their own baseline injury rates over two or three training cycles. Where injury rates are too high, future injury rates should be successively lower than the previous quarter’s rates.

(d) If average unit APFT scores are used at all, “zero” scores for trainees who cannot take the APFT due to an injury profile should be included when computing the unit average score. This practice ensures that the APFT average score more accurately reflects true unit physical readiness.

(e) Require commanders at all levels to routinely monitor injuries and performance by including unit injury profile rates as well as APFT pass rates in reports to higher headquarters. This will encourage greater command responsibility for unit physical performance and musculoskeletal health, both of which are affected by unit PT.

(f) Consider unit APFT pass rates and injury rates, not just unit average APFT scores, when rating officers and noncommissioned officers, since physical readiness is a function of both physical performance and injury.

b. Other PT-related injury prevention interventions are discussed in the following paragraphs.

(1) Instruct trainees to replace their running shoes every 400 to 600 miles, when visibly worn, or every 6 to 9 months, whichever comes first. The support and cushioning characteristics that protect against lower extremity injuries are reduced by nearly one-half after approximately 500 miles of running due to the biomechanical forces placed on them by thousands of footsteps (breakdown is accelerated when running shoes are worn for other activities such as drill and ceremony, sports, and personal time).

(2) Provide trainees with acrylic-blend or polyester-blend (non-cotton) socks (for example, Coolmax) to prevent blisters during running and foot marching. The hydrophobic, wicking properties of the synthetic blended socks draws moisture away from the skin, thereby reducing blister formation by reducing the friction between the skin and footwear, improving hygiene, decreasing athlete’s foot, and minimizing other secondary infections common to the feet. Adding a very thin nylon or polyester sock liner can further enhance protection against blister formation during longer foot marches.

(3) Provide each trainee with easy access to crushed ice and plastic ice bags to aid in the early self-treatment of minor injuries. This can be accomplished by placing a minimum of one ice machine in each company area. Trainees should be instructed on the appropriate use and benefits of early application of ice to keep minor injuries from becoming more serious ones that may require a profile or more aggressive treatment. The benefits of early application of ice are well known, which is why it is widely used as a standard of athletic and occupational injury care.

(4) Require and enforce mandatory wear of mouthguards for all training activities for which the risk of orofacial injuries is high (for example, individual movement technique training, hand to hand combat, rifle bayonet course, confidence course, and pugil stick training). TRADOC Regulation 350-6, Change 2 (June 2004) specifically requires the fitting and issue of mouthguards at medical inprocessing and the use of mouthguards during specific training activities. Those TRADOC posts where trainees are required to wear mouthguards have reduced orofacial injuries by 40 percent. Civilian studies generally agree that mouthguards reduce orofacial injuries.

Appendix E
The Aberdeen Proving Ground
Injury/Illness Surveillance Systems

E–1. Medical-based system

This system is dependent on USACHPPM's MTF personnel and surveillance experts to enter and analyze data and produce reports. Every Soldier reporting to the Aberdeen Proving Ground clinics provides information on the nature of their injury to the healthcare provider. Based on this information, the healthcare provider diagnoses the type of injury/illness. At the end of each week these data are scanned into a computer, and a software program is used to calculate injury rates by company and battalion. Data are then manually plotted on graphs as shown in figure E–1 and figure E–2. These graphs are sent by e-mail to the commanders on a weekly basis. The horizontal line in the center of figure E-2 represents the average injury rate for the previous quarter.

E–2. Company-based system

a. This system captures Soldier injury information such as the location of injury (body part), type of injury (traumatic or overuse), associated activity, medical diagnosis, activity restrictions, and profile length. It is also a profile tracking system for command and cadre use. Each Soldier that enters an MTF receives a modified profile; the Soldier gives this profile to the company Operations Sergeant. The Operations Sergeant enters the data into a Microsoft Access database. Automated reports, generated from the database for any time frame, can be used for quarterly training briefs, reviews and analysis, or daily cadre profile reports. Figure E–3 shows a portion of the physical profile report which enables drill sergeants to track when trainees come off profile and what common limitations to activity they might have.

b. A master APFT and profile tracking system at the company level —

(1) Provides greater visibility of physical performance and training-related injuries;

(2) Strengthens local command decision-making and management of trainees on a day-to-day basis; and

(3) Permits commanders, cadre, and subject matter experts to evaluate the success of targeted injury prevention interventions.

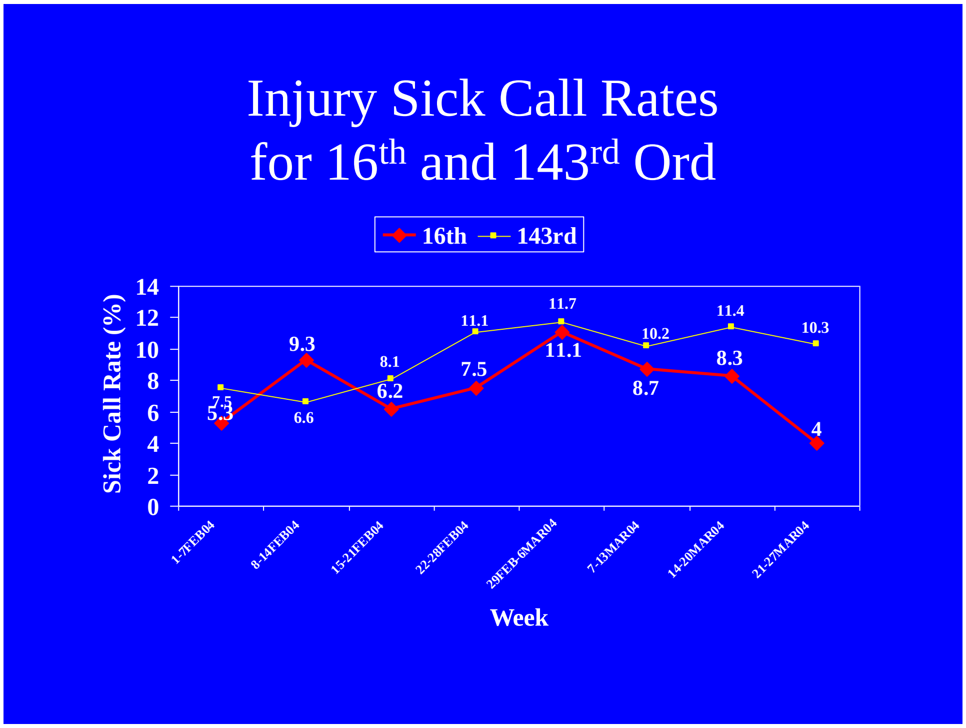

Figure E–1. Graph depicting two battalions of a brigade from the Aberdeen Proving Ground injury/illness surveillance systems

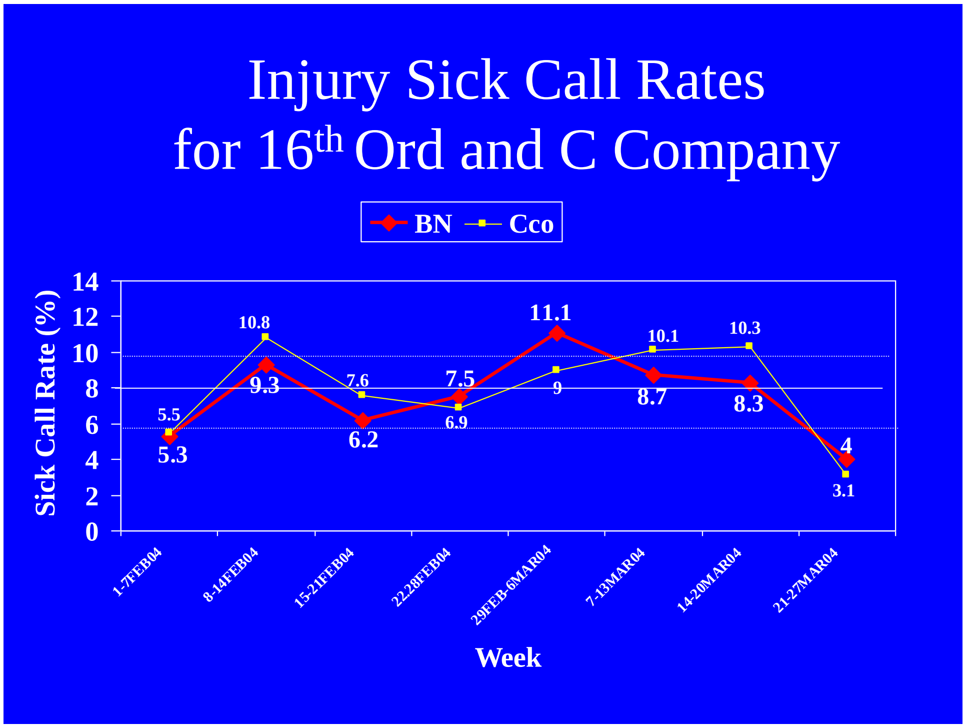

Figure E–2. Graph comparing one company within its battalion from the Aberdeen Proving Ground injury/illness surveillance systems

Limitation: No lifting over 20 lb	**Profile start date**	**Profile end date**	**Recovery date**
Tarby, Andrew D.	7/6/2001	7/16/2001	8/5/2001
Saenz, Luis M.	7/3/2001	7/21/2001	8/26/2001
Barrett, Rickie A.	7/3/2001	7/24/2001	9/4/2001
Bass, Jeremy W.	7/18/2001	7/28/2001	8/17/2001
Weis, Kevin M.	7/5/2001	8/5/2001	10/6/2001
Crozier, Eric C.	7/23/2001	8/23/2001	10/24/2001

Figure E-3. Physical Profile Report

Glossary
Section I. Abbreviations

AGR
Ability group run

AIT
Advanced individual training

AMSA
U.S. Army Medical Surveillance Activity

APFT
Army Physical Fitness Test

AR
Army Regulation

ATC
Army Training Center

BCT
Basic combat training

BID
Latin for *bis in die*: twice a day

BMI
Body mass index

CIPC
Command Injury Prevention Council

CY
Calendar year

DA Pam
Department of the Army pamphlet

DOMS
Delayed onset muscle soreness

IET
Initial entry training

IPFA
Initial physical fitness assessment

MOS
Military occupational specialty

MTF
Medical treatment facility

NCO
Noncommissioned officer

NSAID
Nonsteroidal anti-inflammatory drug

OSUT
One Station Unit Training

PT
Physical training

QID
Latin for *quater in die*: four times a day

RICE
rest, ice, compression, elevation

SEAL
sea-air-land

SME
subject matter expert

SPT
standardized physical training

TB MED
Technical bulletin, medical

TID
Latin for *ter in die*: three times a day

TRADOC
U.S. Army Training and Doctrine Command

TRIR
Training-related injury report

USACHPPM
U.S. Army Center for Health Promotion and Preventive Medicine

VA
Veterans Administration

Section II. Terms

Injury prevention
Practices consistent with minimizing the risk of injury to groups or individuals. These practices may include assessing risk, managing risk, teaching and implementing injury-reducing behaviors and policies, and living in ways that minimize risk of injury.

Musculoskeletal condition
Any adverse health-related condition that results primarily from injury or dysfunction of the musculoskeletal system: the bones and muscles of the body with associated connecting structures including the joints.

Musculoskeletal injury
Injury to the musculoskeletal system induced by trauma or repetitive overuse. Training-related musculoskeletal injuries include minor muscle strains, contusions, tendinopathy, fasciitis, bursitis, muscle or tendon tears or ruptures, joint sprains or complete ligament tears with joint instability, joint dislocation, bone fractures, cartilaginous disruptions, bone stress reactions and stress fractures, and other related injuries.

By Order of the Secretary of the Army:

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