

Injuries during Marine Corps Officer Basic Training

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On average, about 25% of male and 50% of female enlisted recruits sustain one or more injuries during basic training. Because data on military officer populations are sparse, this study investigated injury incidence, injury rates, and modified duty days that occurred during Marine Corps officer basic training (6 weeks in length). Subjects were 480 officer candidates (including 30 females) undergoing training at Quantico, Virginia. The cumulative injury incidence (one or more injuries) was 60.8%, and the injury rate was 3.9 per 1,000 candidate hours of training. There were 378 primary injury encounters (first visit for a specific injury). The highest injury rates occurred during weeks 2, 3, and 6. Male injury categories with the highest rates (injuries per 100 trainees per 1,000 training hours) were blisters (0.68), sprains (0.58), and bone stress reactions (0.40). The highest injury rates in females were for bone stress reactions (1.35). On average, a total of 3.1% of training days constituted modified duty for each candidate. This study provides basic descriptive injury data for this unique military population that can assist in future planning for injury management and preventive interventional strategies.

Introduction

Numerous studies demonstrate that training injuries are common occurrences in military populations.¹⁻¹² The incidence and distribution of injuries have been reported for military recruits across the U.S. uniformed services and even for countries other than the United States.¹³⁻¹⁵ Studies show that on average about 25% of men and about 50% of women are injured at least once during basic training.^{5-7,11,16,17} The incidence of injury for infantry soldiers is similar if corrected for exposure time,^{8,18} but the incidence may be lower for other specific military occupational specialties.¹⁹

Although enlisted basic training, U.S. Military Academy cadets, and infantry officer populations have been investigated, no study to date has examined injuries in Marine Corps officer basic training. The purpose of this study was to fill this gap by examining injury incidence, injury rates, and injury types and distribution during Operation Bulldog. Operation Bulldog is the official code name for the 6-week summer basic training cycle of

Marine Corps officer candidates at Quantico, Virginia. This form of military training is physically challenging and vigorous. This study describes the unique injury profile in this highly motivated group of young men and women.

Methods

Subjects

Four hundred eighty-nine officer candidates were in the initial sample (including 30 females). They were divided into three training companies. All participants were briefed on the purposes and risks of the investigation and gave their informed voluntary consent to participate. Before training, all candidates were examined, and 9 were excluded for medical conditions existing before service. Therefore, 480 candidates were included in the data analysis. During the study, 23 candidates left training for medical reasons and 63 departed for administrative service-related reasons.

Training

The officer candidate training took place during 6 weeks in midsummer 1997. All subjects completed physical fitness and military training according to a specific predetermined schedule. Male and female candidates completed the same training. The training cycle included an assortment of formal physical training sessions three to five times per week, drill and ceremony, and field training exercises. Formal physical training included formation runs, release runs, leadership reaction course, obstacle course, and conditioning hikes. Drill included only close order drill and ceremony. Field training included hand-to-hand combat, offensive/defensive field maneuvers, land navigation, small unit leadership evaluation, the combat confidence course, and the "crucible." These training endeavors involved negotiation of rugged terrain under tactical conditions. The combat confidence course is practiced weekly and involves negotiating 12 obstacles. Five obstacles involve water barriers. The crucible is the "graduation exercise" in which Marine officer candidates conduct sustained tactical operations in the field for 3 days. Training schedules were reviewed to calculate the time spent in each training category. Training categories included physical training, drill and ceremony, and field training. Marching to and from training areas was not clearly defined in the schedules and therefore could not be studied.

Medical Care

The Navy fields a medical task force in support of Operation Bulldog with primary intervention provided by corpsmen, physician assistants, physical therapists, and physicians. The corpsman is the vital link in this system. Corpsmen are often the first medical responders, with patient referrals made up the medical chain of command as clinically indicated. Corpsmen

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Human subjects participated in this study after giving their free and informed voluntary consent. The research protocol was reviewed and accepted by the Uniformed Services University of the Health Sciences. Investigators followed provisions of AR 70-25.

The opinions or assertions contained herein are the views of the authors and are not to be construed as official or as reflecting the views of the Department of the Army or the Department of Defense.

This manuscript was received for review in May 1999. The revised manuscript was accepted for publication in September 1999.

vary in level of medical training from medical technicians able to administer first aid and provide medical histories to the independent duty corpsmen, who have 1 year of formal medical training along with military seniority. Independent duty corpsmen practice with oversight from a physician or physician assistant and are fully capable of managing routine sick-call problems. For Operation Bulldog, the medical task force included 14 corpsmen of varying experience, 5 independent duty corpsman, 2 physical therapists, 2 physical therapy technicians, 2 physician assistants, 1 internal medicine physician, and 1 sports medicine physician. The primary referral hospitals were DeWitt Army Community Hospital at Fort Belvoir, Virginia, and the National Naval Medical Center in Bethesda, Maryland.

Data Acquisition

For the purposes of this study, data were obtained from: (1) entry questionnaires, (2) individual medical records, and (3) the daily medical log. The entry questionnaire was administered before training (day of arrival at Quantico) to describe certain pretraining characteristics of the subjects. It included questions on self-assessed fitness levels, degree of previous military training, footwear, foot problems, and behavioral characteristics such as tobacco use. The medical record was maintained in the troop medical clinic (TMC) and was a legal chronological document that contained the history of medical care for the individual Marine Corps officer candidate. The medical log was the document that captured each medical encounter based on date of visitation to the corpsman in the barracks or the medical provider in the TMC. Medical logs from both the barracks and the TMC were reviewed daily. Information recorded included identifying information, company, new/follow-up visit, complaint, provider, diagnosis, and duty status. Duty status designated the level of permissible activity (full duty, modified duty, quarters, or hospitalization) and, when appropriate, the length of the assignment. Individual candidate medical records were reviewed in cases in which the patient logs had deficient data. Instruction aimed at standard methods of examination, diagnosis, and registration routines was given along the medical chain of command with oversight from the medical director.

Injuries

Injuries were classified as acute traumatic if they were associated with a sudden precipitating event. All other injury types were classified as overuse. Severe injuries were defined as those that involved modified duty for 4 days or more. Specifically, bone

stress fractures were diagnosed as such after obtaining appropriate clinical correlation with a nuclear medicine bone scan.

The first visit to a provider for an injury was recorded as a primary injury encounter. Subsequent visits for the same injury were considered follow-up injury encounters. An officer candidate might have more than one primary injury encounter if the subsequent injury differed from the first injury. A barracks encounter that included referral to the TMC was registered as a primary injury encounter in the barracks and as a follow-up injury encounter in the TMC.

Statistical Analysis

Univariate statistical analyses, including means, standard deviations, and χ^2 , were calculated using the Statistical Package for Social Sciences, version 7.0, for Microsoft Windows 95.

Results

Entry Questionnaire

Questionnaires were obtained from 458 of 489 subjects (94%). The mean age was 22 years. Mean height and weight were 69.8 inches and 166.6 pounds, respectively. Sixty-one percent of candidates described their entry fitness level as 4 or higher ("above average") on a 5-point scale. Mean 2-mile run time was 14 minutes. Nearly 30% of candidates were prior active duty military personnel. Officer candidate ages ranged from 18 to 30 years, with the largest grouping (54%) at ages 20 to 22 years. Tobacco product use in this study group was reported at 14%. Eighty-six percent of the candidates reported arriving at camp with a pair of broken-in boots. Ten percent of the candidates reported arriving at camp with blisters on their feet.

Training

The hours of scheduled training per week devoted to three categories of training (formal physical training, marching, and field training) are shown in Table I. In the 6-week period, the 394 graduating candidates completed approximately 87,468 hours of physical training (222 training hours per candidate). The total number of training hours (hours \times subjects) in each specific category of physical training was: formal physical training, 25,369 hours (26.1%); drill and ceremony, 12,686 hours (13.1%); and field training, 59,109 hours (60.8%).

Weeks 2, 3, and 4 had the largest concentration of physical training hours. The operational tempo is purposely esca-

TABLE I
TRAINING TIME BY CATEGORY AND WEEKLY INJURY RATES

Week	Marine Population (n)	Physical Training (hours per trainee)	Drill and Ceremony (hours per trainee)	Field Training (hours per trainee)	Weekly Injury Rate (%)	Weekly Injury Rate by Training Hours (cases per 1,000 person training hours)
1	480	6	4	0	3.3	3.3
2	474	9	5	29	18.4	4.27
3	465	14	4	23	27.3	6.66
4	447	12	4	24	13.6	3.41
5	399	9	4	60	12.5	1.72
6	394	7	8	0	7.9	5.26

lated during these weeks to serve as a physical discriminator among candidates. This sentiment was echoed from the training cadre and was realized in the sick-call numbers from medical staff observations.

Injuries

There were 292 individuals who sustained one or more injuries. Thus, the overall cumulative injury incidence (candidates with one or more injuries) was 60.7%. The cumulative injury incidence for male and female candidates was 59.5% and 80%, respectively (risk ratio = 1.3, $p = 0.026$). The injury rate expressed as person hours was 3.9 injuries per 1,000 person hours of physical training.

Among men, there were 378 primary injury encounters. Overuse injuries made up 65.2% of these, and traumatic injuries made up 34.8%. Among women, there were 27 primary injury encounters. Overuse injuries made up 70.3% of these, and traumatic injuries made up 29.7%. One hundred ten injuries (29%) sustained by the candidates were classified as severe injuries (4 or more days of modified duty). Less severe injuries (268) accounted for 71% of all injuries.

The weekly ratio of primary injury encounters is depicted in Table I. The highest injury rates were found in weeks 2 and 3. However, injuries expressed in this manner do not take the hours of exposure to training into account. Table I also shows the primary injury encounter normalized for exposure to physical training. When injury rates are expressed in this manner, the highest ratio was recorded in the third and sixth weeks of training.

The frequencies of various injury categories in this study are documented for both male and female trainees in Table II. The highest male injury rate was for blisters, followed by sprains, bone stress reaction, and knee injuries. The highest female

injury rate was for bone stress reaction, followed by infected blisters. In this study population, a total of seven stress fractures (overall incidence of 1.4% during the 6 weeks of training) was recorded. All of the stress fractures involved the tibial shaft.

The anatomical distribution of injuries sustained by both male and female candidates during Marine Officer candidate school is depicted in Figure 1. The most common injury locations for men and women were similar. For men, these were the foot/ankle region, the knee, and the lower leg. These regions combined account for 72% of the body parts injured. For women, these were the foot/ankle region, the lower leg, and the knee. These regions combined account for 78% of the body parts injured.

Modified Training Days

During the 6-week training period, injuries were responsible for 446 male and 60 female modified training days (an average of 3.1% of all training days for each person). Overuse injuries were responsible for 284 male and 50 female modified training days (0.62 and 1.67 training days per male and female candidates, respectively), and traumatic injuries were responsible for 162 male and 10 female modified training days (0.35 and 0.20 training days per male and female candidates, respectively).

Modified training days for injuries sustained are shown in Table III for anatomical sites and diagnoses occurring with higher frequencies. Foot injuries were responsible for the most limited training days in the male candidate. Tibial bone stress reactions were responsible for the most limited training days in the female candidates. The injury site with the most days modified per injury was the knee. The highest number of limited training days per injury type was for stress fracture among men and for sprains among women.

TABLE II
OPERATION BULLDOG '97 INJURY FREQUENCIES AND INJURY RATES

Injury	Diagnosis	Male Primary Encounters (n)	Male Follow-Up Encounters (N)	Male Injury Rate	Female Primary Encounters (n)	Female Follow-Up Encounters (N)	Female Injury Rate
Overuse	Blister	68	87	0.68	1	1	0.15
Overuse	Stress reaction	40	74	0.4	9	24	1.35
Overuse	Infected blister	31	72	0.31	4	4	0.6
Overuse	ITBS	14	34	0.14	1	8	0.15
Overuse	Ingrown nail	14	25	0.14	0	0	0
Overuse	Knee, NOS	13	34	0.13	1	3	0.15
Overuse	Other tendonitis	11	16	0.11	1	3	0.15
Overuse	RPS	10	20	0.1	0	0	0
Overuse	Pain, NOS	7	10	0.07	0	0	0
Overuse	Achilles tendonitis	7	15	0.07	0	0	0
Overuse	Bursitis	5	12	0.05	0	0	0
Overuse	Stress fracture	5	15	0.05	2	6	0.3
Overuse	Fascitis	4	13	0.04	0	0	0
Trauma	Sprain	58	136	0.58	1	5	0.15
Trauma	Abrasion/laceration	24	41	0.24	1	6	0.15
Trauma	Strain	19	41	0.19	1	3	0.15
Trauma	Contusion	14	29	0.14	2	2	0.3
Trauma	Closed head injury	4	6	0.04	0	0	0
Trauma	Dislocation	2	7	0.02	0	0	0
Trauma	Fracture	1	1	0.01	1	2	0.15

Injury rate = primary encounters per 100 trainees per 1,000 training hours; ITBS, iliotibial band syndrome; RPS, retropatellar pain syndrome; NOS, not otherwise specified.

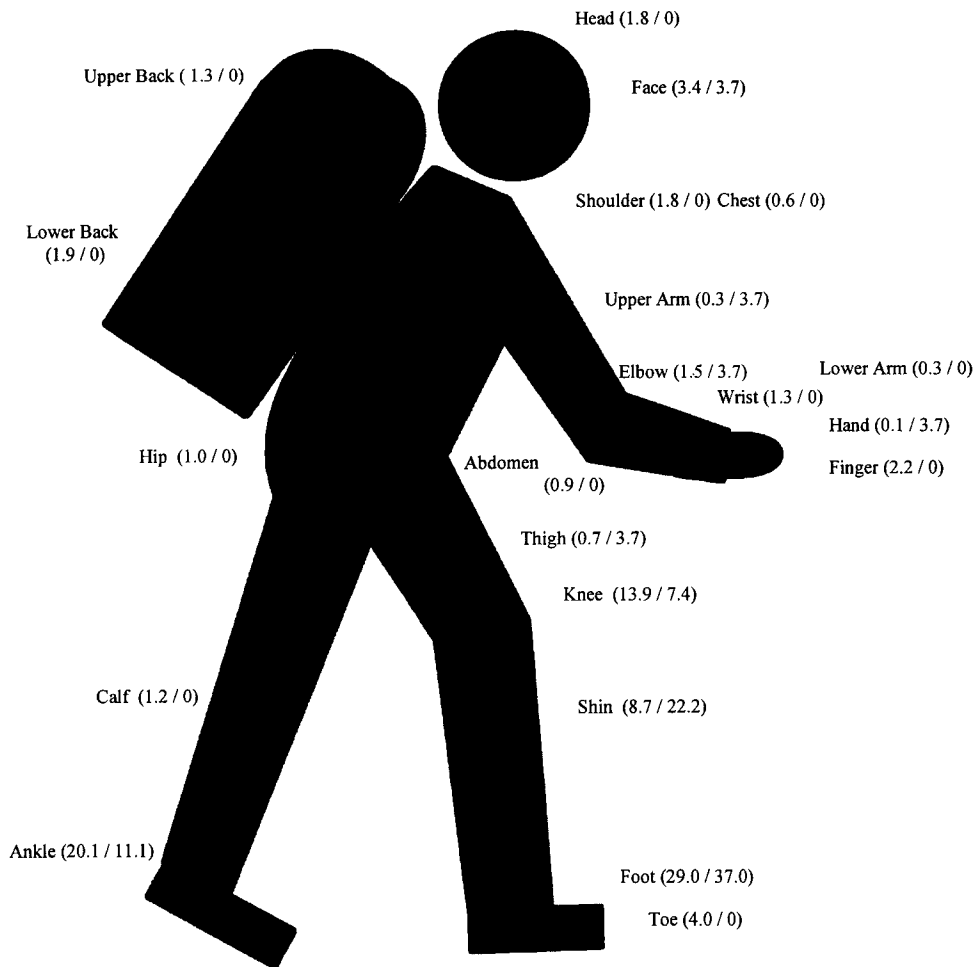


Fig. 1. Distribution of injuries by body part. Numbers refer to percentages of primary injury encounters for each body part (male/female). A body part was not specified in about 4% of injuries.

TABLE III

TOTAL NUMBER OF MODIFIED TRAINING DAYS PER INJURY FOR SELECTED COMMON INJURIES AND MAJOR ANATOMICAL SITES

Anatomical Site or Injury ^a	Total Days Modified (Male/Female)	Days Modified per Injury (Male/Female)
Ankle	90/4	0.66/1.33
Knee	85/9	2.93/4.5
Foot	104/11	0.53/1.10
Blister (total)	77/2	0.77/0.40
Sprain	93/4	1.60/4.00
Bone stress reaction	64/30	1.60/3.33
Bone stress fracture	19/7	3.80/3.50

^aOverlap exists with the categories selected.

Discussion

This study is the first to document injury incidence and frequency in Marine Corps officer basic training. The cumulative incidence of all injuries (61%) recorded in this study exceeds that in most studies documenting injury incidence over time. In these other studies, the incidence of injury varies from 27% to 57% for males and from 51% to 61% for females. The training

periods vary from 8 to 12 weeks. In studies making direct comparisons of men and women, women are about twice as likely to get injured.^{1,5,7-9,20,21} In the present study, women were at elevated risk compared with men but the relative risk (1.3) was considerably lower than the enlisted basic training relative risk level.

The reason for a higher injury incidence in this study is likely multifactorial and involves differences in injury definition, training variations, timing of injuries, and availability of medical care. Table IV shows some of the comparison data, including weekly injury rates. One concern is the definition of injury. Our study includes acute traumatic and overuse components in its injury incidence calculation. The types of injuries described in other studies are often overuse in nature, with the addition of sprains and strains. Large groups of acute injuries are not reported in some studies.^{1,10} These underreported injuries include lacerations, abrasions, contusions, fractures, and closed head injuries.

Variations in training doctrine are likely to contribute to the differences seen when the injury incidence results from this Marine officer study are compared with Army officer,¹³ enlisted,^{2-6,11,12,16} cadet,¹ and operational Army studies.^{8,18,19} Higher injury rates might be suspected where emphasis is placed on one or more of the three training areas: physical

TABLE IV
COMPARISONS OF INJURY RATES AND LOWER EXTREMITY INVOLVEMENT DURING MILITARY BASIC TRAINING

Service/Type of Service Member ^a	Training Time (weeks)	Male/Female (N)	Injury Definition	Injury Rates (percent per week) Male/Female	Lower Extremity (% of total injuries)
Marine/recruits ¹⁰	12	8,076/0	Overuse and some acute	4.8/NO ^b	81.9
Army/infantry recruits ⁶	12	303/0	Overuse and some acute	3.8/NO	NO
Army/infantry ²¹	9	1,261/0	Overuse only	3.5/NO	81
Army/cadet ¹	6	473/85	Overuse and some acute	4.6/10.1	NO
Army/recruits ⁵	8 and 8	124/186 and 1,349/896	Overuse and some acute	3.4/6.3 and 3.4/5.4	85-90+
Army/recruits ¹¹	8	0/400	Overuse and some acute	NO/6.7	54
Marine/officer candidates (present study)	6	459/30	Overuse and acute	9.6/13.3	75

^aSuperscript numbers indicate reference citations.

^bNO, no data present.

training, marching, or field time. Others have documented the incremental impact of weight-bearing exercise and long-distance running on injury rates.^{16,18,22} In this study, Marine officer candidates were performing regular exercise training, drill and ceremony, and activity in the field while carrying packs, weapons, and equipment. Further discussion on the unique impact of the Marine training environment will follow below when foot and ankle injuries are discussed.

Injury rates vary by week, as shown here and in a previous study.¹⁶ The highest injury rates were documented in the third week and the last week of training (Fig. 1). Some of this is attributable to the increased training tempo and the level of physical fitness upon arrival at camp.^{6,7,16} Scientific physiologic evidence has demonstrated that maximal bone remodeling and vulnerability exist during weeks 2 and 3 of training.²³ Additionally, because this study captured injury incidence during a shorter period of time (6 weeks), the larger injury rates typical in the first 3 weeks of training (Table I) could inflate the overall injury rate. Also, an exacerbation of minor injuries or an accumulation of several limited overuse injuries may be more apparent in this shorter time period.

The availability of timely medical assistance was high in this operation. Each training company had four corpsmen and one independent duty corpsman assigned. These providers administered care on "the deck plates." Candidates had access to them in the barracks starting at 5:00 a.m. and at all training sites. Additionally, one physical therapy technician was centrally located in the candidate barracks at 5:00 a.m. to screen and treat many injuries, which facilitated rapid return-to-duty rates. This commitment to timely and effective medical care contributed to higher patient contact frequencies, and its success is reflected in a high return-to-duty rate.

This study reports the incidences of specific injuries. It is clear that male Marine Corps candidates develop blisters, followed by sprains, bone stress reactions, and knee injuries. In other studies, blisters often are unreported and bone stress reactions and knee injuries represent major injury categories.^{20,21} The injury rates of male bone stress reactions (0.40 per 1,000 training hours) and knee injuries (0.37 per 1,000 training hours) are comparable to those reported by Jordaan and Schweltnus²¹ with tibial bone stress reactions (0.34 per 1,000 training hours) and knee injuries (0.3 per 1,000 training hours).

Although it had a limited female population, this study supports bone stress reactions as the predominant injury category for women in basic training.^{1,11}

Most of the injuries in this study were overuse injuries, particularly involving the lower extremity. The percentage of lower extremity injuries in this study follows a similar trend seen in other military training populations,^{5,10,21} as shown in Table IV.

Unlike several studies that cite the knee as the most common anatomical location for injury,^{5,13,16} we found the greatest number of injuries in the foot and ankle. Linenger and West¹⁰ and Knapik et al.,⁸ likewise, reported this occurrence. The findings in this study may reflect the heightened awareness of foot care and blister management that resulted from a parallel clinical investigation of the incidence of blisters. Besides heightened awareness of foot care, Marine training differs in other ways from most basic training and infantry environments. Marines negotiate wet riverside and lake environments as a practical portion of normal training operations. Friction induced by moisture has been hypothesized to increase blister incidence.⁹ The combat confidence course is a prime example of water exposure incorporated into training. Other training maneuvers carry Marines over uneven terrain, often at high speeds in combat boots.

An injury in a unit translates to diminished training hours and compromised military readiness. In the present study, we documented a substantial number of modified training days as a result of injuries, in particular overuse injuries. Knee injuries and tibial bone stress injuries were responsible for the largest number of modified training days. Therefore, interventional efforts should include identifying and modifying risk factors for tibial stress reaction. This may include appropriate selection of modifications to the training schedule during weeks 2 and 3, because maximal bone remodeling and vulnerability occur at this time.

Summary

This study presents research findings on the incidence of injuries during Marine Corps officer basic training at Quantico, Virginia, during the summer of 1997. The study emphasizes that injuries are a significant source of morbidity and modified duty time. This topic is particularly relevant because injuries

create delays for soldiers, sailors, and airmen trying to complete training and move to their next duty stations. The following findings are highlighted.

(1) Blisters account for the highest injury rate. Primary and secondary blister prevention studies should be fielded. Command emphasis on foot care needs to transcend the squad and individual levels.

(2) Injuries occur primarily during the first 3 weeks of training. Therefore, attention could be focused on preventing injuries during this period. The development and implementation of more detailed prescreening tools could effectively identify anatomical and demographic variants more prone to injury. Individual commands should give attention to modifying physical training loads during weeks 2 and 3. Some preliminary work in this area has been completed.^{16,17,22}

(3) Bone stress reactions account for the majority of lost training days per injury. Continued studies are needed in the prevention of tibial bone stress reactions.

Acknowledgments

We thank CDR Craig Bischoff, CDR Paula Suzanne, MAJ Julie Kenner, and Ms. Terri Thomson.

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