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Injury in Female Marine Corps Recruits: A Historical
Prospective Study

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13. ABSTRACT (Maximum 200 Words) The purpose of this study was to determine the impact of lower extremity musculoskeletal injury (MSI) and of stress fracture (SFX) during recruit training on first-term enlistment (4-yr) hospitalizations and attrition of female Marine Corps recruits. The Naval Health Research Center studied 2,715 female recruit graduates between 1995 and 1999 and evaluated their first-term attrition. No differences by MSI status were seen in hospitalizations, however several differences were found for attrition. Women who graduated after incurring training MSI and especially SFX were less likely to complete their first-term enlistment. Because 44% of the women who graduated had incurred a lower extremity MSI during training, this could significantly affect military readiness. The effect is even stronger among female graduates who had SFX during training. Women who graduated after incurring training MSI and especially SFX were less likely to be promoted to corporal during the first-term enlistment. Women who incurred training MSI were less likely to re-enlist; however, the effect of SFX was not statistically significant. Too many first-term separations can impact the operational readiness of the Fleet Marine Force. The need for the Fleet to write instructions suggesting injury prevention guidelines during the accession pathway may be warranted.				
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FIRST-TERM OUTCOMES ASSOCIATED WITH LOWER EXTREMITY INJURY IN
FEMALE MARINE CORPS RECRUITS: A HISTORICAL PROSPECTIVE STUDY

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First-term Outcomes Associated with Lower Extremity Injury in Female Marine Corps Recruits: A Historical Prospective Study

INTRODUCTION

The Naval Health Research Center (NHRC) has conducted injury research at Marine Corps Recruit Depot (MCRD), Parris Island and San Diego from 1992 through 2000. Among a cohort of 1,296 male recruits from MCRD San Diego, those who suffered from a stress fracture (SFX) during recruit training and still graduated were 2.14 times more likely to be discharged before the end of their first-term enlistment for any reason; 6.12 times more likely to be discharged prior to the end of their first-term enlistment due to a physical disability (1).

The NHRC also studied 3,786 female Marine Corps recruits at MCRD Parris Island. Of those, 2,715 female recruits graduated between 1995 and 1999. The purpose of the present study was to determine the impact of lower extremity musculoskeletal injury (MSI) and of SFX during recruit training on first-term enlistment (4-yr) hospitalizations and attrition of female Marine Corps recruits. Additionally, three measures of success were examined: completion of the first-term enlistment (4 yr); completion of the first-term enlistment at the rank of corporal; and retention beyond the first-term enlistment (2).

HYPOTHESES

a) There is no difference in first-term enlistment hospitalizations and attrition between female Marine Corps recruit graduates who suffered a lower extremity musculoskeletal injury during recruit training and those who did not.

b) There is no difference in first-term enlistment hospitalizations and attrition between female Marine Corps recruit graduates who suffered a stress fracture during recruit training and those who did not.

MATERIALS and METHODS

Subjects and Recruitment

The study design was historical prospective; the Marine Corps recruits were enrolled after appropriate institutional review board approval for human subject research. Female recruits were studied at MCRD Parris Island in Beaufort, South Carolina. Recruit volunteers were obtained in two cohorts, the first cohort was obtained between June 1995 and September 1996 and the second cohort was obtained in 1999. Recruit volunteers were given a consent form during the end of recruit processing and then administered a questionnaire. At the end of data accrual, a total of 3,786 female recruits were enrolled. Surveys from 1,071 recruits who did not complete basic training were not included in the analysis, resulting in a sample size of 2,715 female Marines (72% graduated).

The recruits were followed through the 12 weeks of training to ascertain the incidence of SFX and other MSI, discovered by self-referral during sick call to the branch medical clinic or battalion aid station. Recruits who reported SFX or other MSI were followed by a medical

examination; some recruits entered the medical rehabilitation platoon for injury rehabilitation, healed and were and reassigned, eventually graduating longer than 12 weeks on board. Stress fracture case definitions conformed to strict ICD-9-CM Expanded Orthopedic classifications and were confirmed by radiography and/or nuclear bone scans.

Questionnaire

A paper-and-pencil questionnaire included self-reports of exercise history, perceived physical fitness, previous MSI, menstrual, and sociodemographic variables. Measures were either existing standard items or were developed by research staff, such as exercise history.

Hospitalization Data

The Career History Archival Medical and personnel System (CHAMPS) at the NHRC was accessed to collect first-term enlistment hospitalizations (3). CHAMPS collects tri-service inpatient and outpatient data from the Department of Defense (DoD) Corporate Executive Information System (CEIS) standard inpatient data records (SIDR) database of admissions to DoD medical treatment facilities and the standard ambulatory data record (SADR) which identifies outpatient cases. These data are then incorporated into a chronological longitudinal record. The SIDR and SADR electronic records identify diagnoses in the ICD-9 format.

Attrition Data

The CHAMPS database was used to collect 3 types of attrition data: completion of the first-term enlistment (4 yr); completion of the first-term enlistment at the rank of corporal; and retention beyond the first-term enlistment. The main source for CHAMPS validation of career and demographic information among active-duty military personnel is the Defense Enrollment Eligibility Reporting System (DEERS). DEERS is the central source for personnel information from the DoD Personnel community. This database is used to determine medical benefits eligibility, insurance, immunizations, and patient information. Using information codes from DEERS, CHAMPS is able to provide a detailed chronological record of changes in occupational specialty, duty station assignments, medical and career events. The longitudinal structure of the CHAMPS format facilitates prospective epidemiologic studies and its design is well suited to the statistical techniques used in survival analysis.

Injury Data

All recruits were followed throughout basic training for occurrence of lower extremity musculoskeletal injuries, with specific attention to SFX. Injury data for graduates were gathered from reviewing each subject's medical record at the completion of training. The injury data extracted from the medical records included injury site, and specific final diagnosis. The Branch Medical Clinic, according to standard case definitions, routinely confirmed all SFX among the subjects either radio-graphically or scintigraphically. Stress fractures were defined as partial or complete fatigue fractures of insidious onset in nondiseased bone. Diagnosis of SFX was based on 1) clinical presentation of localized pain of insidious onset, without prior acute trauma, aggravated by repetitive weight-bearing activities and relieved with rest; and 2) a confirmatory (+) radiograph and/or bone scan at a site consistent with the clinical presentation. A positive (+) radiograph was defined as presence of periosteal reaction, endosteal callus formation, and/or a fracture line in an otherwise normal bone. A positive bone scan was defined as the presence of 3+ to 4+ intensity localized fusiform uptake at the site of pain.

For analysis purposes, three injury measures were created: "Any Injury" defined as one or more lower extremity MSI; "Stress Fracture" defined as one or more SFX to any site; and "Pelvic/femur Stress Fracture" defined as one or more SFX to the pelvic or femoral sites.

Outcome Measures

Hospitalizations: The data on hospitalizations included the total number of hospitalizations from the date of graduation to the end of the first-term. A second measure of hospitalizations included only those hospitalizations not related to pregnancy.

Attrition: The three measures that examined attrition and markers of success in the military were (1) discharge during the first-term of service (identified as not completing at least 48 months of service); (2) not being promoted to the rank of corporal or higher within 48 months; and (3) not re-enlisting beyond the initial service obligation (identified as completing at least 52 months of service).

Statistical Analysis

Descriptive statistics were used to characterize participating recruits. Descriptive data included means, medians, percentages, and ranges. Chi-square tests were used to identify statistically significant differences between groups (i.e., recruits who suffered an injury versus recruits who did not suffer an injury during basic training) for discharge prior to first-term, completion of first-term and re-enlistment into the Corps. Logistic regression models were developed to assess the odds of being discharged the first-term enlistment for various injury outcomes during training while controlling for age, ethnicity, and education. Logistic models were also developed for other attrition outcomes including not being promoted to corporal during the first-term and not re-enlisting after the first-term.

RESULTS: Key Research Accomplishments and Reportable Outcomes

Recruit Characteristics

A total of 2,715 female Marine Corp Basic Training graduates participated in the study by completing the initial survey at the beginning of their recruit training. Table 1 (see Appendix A) shows the distribution of characteristics among the female recruits. Enrollees ranged in age from 17 to 32 years, with an average age of 19 years. The women completed a median of 12 years of education. The majority (66%) were Caucasian, followed by 18% African American, 14% Hispanic, 2% Asian and Pacific Islander, and 1.3% American Indian/Alaskan Native. Prior to basic training, women reported their height and weight, ranging from 53 to 73 inches and 87 to 187 pounds, respectively. The mean height was 64 inches (2.57 SD) and the mean weight was 128 pounds (14.53 SD). At time of entry in the USMC, the mean body mass index (BMI) was 22 (SD 1.93, range 16 to 33).

Injury and Fracture Incidence

Table 1 (see Appendix A) shows injury and fracture percentages of female recruits during training. During the basic training period, 1,191 of the women who graduated had suffered an injury, corresponding to an injury rate of approximately 44%. Among the female graduates with

injuries, 96 women had confirmed SFX, corresponding to a rate of 3.5%. Stress fractures of the pelvis or femur during basic training occurred in 42 female graduates (1.5%).

Outcome Measures

Hospitalizations

About 21% of the women had at least one non-pregnancy hospitalization during the first-term enlistment period (see Table 1 in Appendix A). There were no differences in hospitalizations (either total hospitalizations or non-pregnancy hospitalizations) by injury status (see Tables 2, 3 and 4 in Appendix B).

Attrition

About 30% of the women were discharged during their first-term (26% among non-injured and 34% among injured). The percentage of women discharged varied by injury status. Among those who had any type of injury during training, 34% were discharged (all-cause) during the first-term while among those with SFX, 43% were discharged (all-cause) during the first-term (see Figure 1 in Appendix C). The odds of being discharged (adjusting for age, race, and education) were 1.5 (95%CI = 1.2-1.7) for any injury, and 1.8 (95% CI = 1.2-2.7) for SFX.

Among the entire group of graduates, 37% were not promoted to corporal during their first-term. This also varied by injury status as shown in Figure 2 (in Appendix D). For those with injuries, 43% were not promoted; for those with SFX, 53% were not promoted and for those with pelvic or femoral SFX 57% were not promoted. The odds ratios ranged from 1.6 for injury to 2.4 for pelvic or femoral SFX and all were statistically significant.

Most women did not re-enlist (about 65%), but those who had been injured during training were less likely to re-enlist than the women who had not been injured during training. The odds of not re-enlisting given an injury were 1.3 (95CI = 1.1-1.5). The relationship with SFX was similar, but these differences were not statistically different. See Figure 3 (in Appendix E).

DISCUSSION

The Chief of Naval Operation's Talking Points for OPNAV Staff (July 26, 2000) emphasized efforts to reduce first-term enlistment attrition. First-term attrition and low first-term re-enlistment directly affect manpower, current and future readiness. First-term attrition and injury prevention are critical to military operational readiness.

Musculoskeletal injuries (MSI) are a significant problem in military recruit populations where unfit individuals are exposed to sudden increases in the volume and intensity of physical activity. MSI during military training are one of the major causes of medical attrition (4). Outpatient visits due to injuries are generally the result of injuries and musculoskeletal disorders associated with physical training and vigorous operational activities. These injuries have a significant impact on readiness. A fracture can account for over 100 lost duty days, and a simple sprain can result in several weeks of limited duty; either would restrict deployment. In the Department of the Navy (DoN), 58% of medical separations are for musculoskeletal / degenerative disorders. In FY 98, 3,668 medically separated Sailors and Marines cost \$146M in recruiting and training costs alone. Not computed are total costs related to disability, hospitalization, prescription medication, lost

man-hours, etc. All told, DoD pays \$1.5B per year in orthopedic disability costs. Furthermore, in relation to the cost of injuries, a relatively small amount of resources are devoted to prevention, surveillance, best practices program implementation, and research of injury causal factors in the DoN. The current status of injury surveillance and prevention efforts in the DoD is fragmented. (4).

It is clear that training injuries are very costly in terms of health care resources and lost training days during recruit training. Injuries can result in temporary and permanent impairments that can interfere with a service member's ability to perform. For example, the estimated fiscal impact of physical disability payments for the U.S. Army was \$500 million for 1994 alone (5). The cost of physical disability in the Marine Corps increased from \$10.1 million in 1989 to \$28.5 million in 1995 (6). MSI can result in immediate separation from recruit training, however, for those recruits who suffered a MSI and completed training, the impact of such injuries has not been assessed beyond the training environment, along the accession pathway, and into the Fleet Marine Force.

Musculoskeletal injuries are costly not only because of health care costs but also the financial loss from attrition. The potential long-term impact of musculoskeletal injuries and SFX training related injuries emphasizes the importance of early identification and prevention in training environments.

CONCLUSIONS

These data suggest that lower extremity injuries during recruit training have an important effect on future military success, even among the women who graduate. Although no differences by injury status during training were seen in hospitalizations, several differences were found for attrition. Women who graduated after incurring training injuries and especially stress fractures were less likely to complete their first-term enlistment. Because 44% of the women who graduated had incurred a lower extremity injury during training, this could significantly affect military readiness. This effect is even stronger among female graduates who had a stress fracture during training, but only about 4% of women are in this category. In addition, women who graduated after incurring training injuries and especially stress fractures were less likely to be promoted to corporal during the first-term enlistment. By the end of the first-term, the effect of injuries was still apparent in that women who had any training injury were less likely to re-enlist; however, the effect of stress fractures was not statistically significant.

Future work needs to be done to compare these rates with rates for male recruits and to explore variables other than age, race and education that may affect this relation.

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PERSONNEL

The following personnel received financial support from this research effort:

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APPENDICES

Appendix A

Table 1. Characteristics of U.S. Marine Corps Female Graduates from Parris Island, 1995-96 & 1999 (N=2,715)

Table 1. Characteristics of U.S. Marine Corps Female Graduates from Parris Island, 1995-96 & 1999 (N=2,715)

Variable	Range	%(n), median, or mean(SD)
SOCIODEMOGRAPHIC		
Age (yrs) entering basic training	17-31	
Mean (SD)		18.99(1.95)
Race (%)		
American Indian / Alaska Native		1.3% (36)
Asian		2.0% (55)
African American		18.2% (493)
Native Hawaiian /		0.1% (2)
Other Pacific Islander		
Caucasian		65.9% (1,788)
Declined to Respond		12.6% (341)
Hispanic		
Hispanic descent (%)		14.3% (387)
PHYSIOLOGICAL RELATED		
Weight (lb) entering basic training	87-187 lbs	
Mean (SD)		127.78 (14.53)
Height (in) entering basic training	53-73 in	
Mean (SD)		64.44 (2.57)
Calculated BMI (kg/m²)	15.8-33.0	
Mean (SD)		21.6 (1.93)
Shoe Size	2.5-12.0	
Median		8
Handedness		
Right Handed (%)		91% (2,434)
OUTCOME VARIABLES		
Any Injury		43.9% (1,191)
Stress Fracture		3.5% (96)
Pelvic/Femur Stress Fracture		1.5 (42)
One or more Hospitalizations, during 1st Term		36.9% (1002)
One or more Non-pregnancy related Hospitalizations, during 1st Term		21.2% (575)
Completion of First-term Service		62.4% (1,694)
Promotion to/above Corporal Rank		63.2% (1,717)
Retention Beyond Initial Service		41.8% (1,136)

Appendix B

Table 2. Association of Career and Demographic Variables with First-term Outcomes Among USMC Female Graduates Who Incurred Any Lower Extremity Injury During Recruit Training

Table 3. Association of Career and Demographic Variables with First-term Outcomes Among USMC Female Graduates Who Incurred Stress Fracture During Recruit Training

Table 4. Association of Career and Demographic Variables with First-term Outcomes Among USMC Female Graduates Who Incurred Pelvic or Femoral Stress Fracture During Recruit Training

Table 2. Association of Career and Demographic Variables with First-term Outcomes Among USMC Female Graduates Who Incurred Any Lower Extremity Injury During Recruit Training

Variable	N	Any Injury % (n)	OR	95% CI
First-term				
Completed 1 st Term	1897	41.4% (785)	1.00 ^a	
Did Not Complete 1 st Term	803	50.4% (405)	1.44*	1.22-1.70
Promotion to Corporal Rank				
Promoted to Corporal	1713	39.5% (677)	1.00 ^a	
Was Not Promoted to Corporal	993	51.8% (514)	1.64*	1.40-1.92
Retention Beyond Initial Service				
Re-enlisted Beyond 1 st Term	942	39.6% (373)	1.00 ^a	
Did Not Re-enlist Beyond 1 st Term	1758	46.5% (817)	1.32*	1.13-1.56
Hospitalizations, 1st term				
No Hospitalizations	1431	44.1% (631)	1.00 ^a	
One or more Hospitalizations	998	44.3% (442)	1.01	0.86-1.19
Hospitalizations, 1st term (excluding pregnancy related)				
No Hospitalizations	1857	44.4% (824)	1.00 ^a	
One or more Hospitalizations	572	43.5% (249)	0.97	0.80-1.17
Age				
19 years of age or younger	2068	44.6% (923)	1.00 ^a	
20 years of age or older	640	41.9% (268)	0.89	0.75-1.07
Race (%)				
Caucasian	1784	43.7% (779)	1.00 ^a	
African American	491	47.7% (234)	1.18	0.96-1.44
American Indian / Alaska Native / Asian / Nat. Hawaiian and other Pacific Islander	93	49.5% (46)	1.26	0.83-1.92
Declined to Respond	340	38.8% (132)	0.82	0.65-1.04
Hispanic Descent				
Non-Hispanic	2322	44.9% (1042)	1.00 ^a	
Hispanic	386	38.6% (149)	0.77	0.62-0.96

^a Indicates reference category

* Indicates statistical significance

Table 3. Association of Career and Demographic Variables with First-term Outcomes Among USMC Female Graduates Who Incurred Stress Fracture During Recruit Training

Variable	N	Stress Fracture %	OR	95% CI
First-term				
Completed 1 st Term	1897	2.9% (55)	1.00 ^a	
Did Not Complete 1 st Term	803	5.1% (41)	1.80*	1.19-2.72
Promotion to Corporal Rank				
Promoted to Corporal	1713	2.6% (45)	1.00 ^a	
Was Not Promoted to Corporal	993	5.1% (51)	2.01*	1.33-3.02
Retention Beyond Initial Service				
Re-enlisted Beyond 1 st Term	942	2.8% (26)	1.00 ^a	
Did Not Re-enlist Beyond 1 st Term	1758	4.0% (70)	1.46	0.93-2.31
Hospitalizations, 1st term				
No Hospitalizations	1431	3.7% (53)	1.00 ^a	
One or more Hospitalizations	998	3.4% (34)	0.92	0.59-1.42
Hospitalizations, 1st term (excluding pregnancy related)				
No Hospitalizations	1857	3.6% (67)	1.00 ^a	
One or more Hospitalizations	572	3.5% (20)	0.97	0.58-1.61
Age				
19 years of age or younger	2068	3.3% (68)	1.00 ^a	
20 years of age or older	640	4.4% (28)	1.35	0.86-2.11
Race (%)				
Caucasian	1784	3.6% (64)	1.00 ^a	
African American	491	2.4% (12)	0.67	0.96-1.26
American Indian / Alaska Native / Asian / Nat. Hawaiian and other Pacific Islander	93	2.2% (2)	0.59	0.14-2.45
Declined to Respond	340	5.3% (18)	1.50	0.88-2.57
Hispanic Descent				
Non-Hispanic	2322	3.4% (80)	1.00 ^a	
Hispanic	386	4.1% (16)	1.21	0.70-2.10

^a Indicates reference category

* Indicates statistical significance

Table 4. Association of Career and Demographic Variables with First-term Outcomes Among USMC Female Graduates Who Incurred Pelvic or Femoral Stress Fracture During Recruit Training

Variable	N	Pelvic/Femur Stress Fracture %	OR ^a	95% CI
First-term				
Completed 1 st Term	1897	1.3% (24)	1.00 ^a	
Did Not Complete 1 st Term	802	2.2% (18)	1.80	0.97-3.32
Promotion to Corporal Rank				
Promoted to Corporal	1713	1.1% (18)	1.00 ^a	
Was Not Promoted to Corporal	992	2.4% (24)	2.34*	1.26-4.32
Retention Beyond Initial Service				
Re-enlisted Beyond 1 st Term	942	1.0% (9)	1.00 ^a	
Did Not Re-enlist Beyond 1 st Term	1757	1.9% (33)	1.98	0.95-4.17
Hospitalizations, 1st term				
No Hospitalizations	1431	1.6% (23)	1.00 ^a	
One or more Hospitalizations	997	1.4% (14)	0.872	0.45-1.70
Hospitalizations, 1st term (excluding pregnancy related)				
No Hospitalizations	1857	1.6% (29)	1.00 ^a	
One or more Hospitalizations	571	1.4% (8)	0.90	0.41-1.97
Age				
19 years of age or younger	2068	1.4% (28)	1.00 ^a	
20 years of age or older	639	2.2% (14)	1.62	0.85-3.12
Race (%)				
Caucasian	1783	1.6% (29)	1.00 ^a	
African American	93	1.0% (5)	0.62	0.24-1.62
American Indian / Alaska Native / Asian / Nat. Hawaiian and other Pacific Islander	491	0% (0)	--	--
Declined to Respond	340	2.4% (8)	1.46	0.66-3.22
Hispanic Descent				
Non-Hispanic	2321	1.6% (37)	1.00 ^a	
Hispanic	386	1.3% (5)	0.81	0.32-2.07

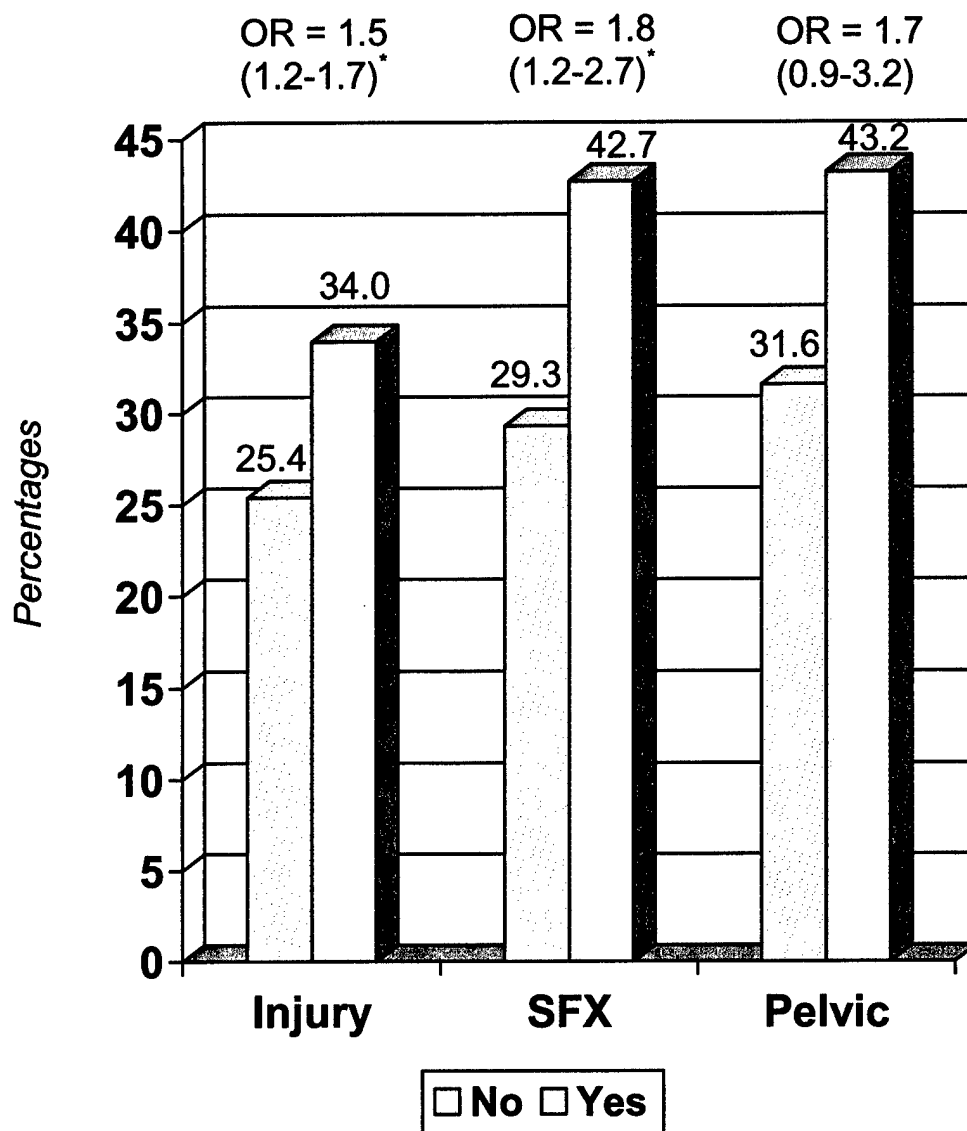
^a Indicates reference category

* Indicates statistical significance

Appendix C

Figure 1: Percentages of USMC Females Discharged (All-Cause) During the 1st Term Enlistment, by Injury During Recruit Training (N=2,715)

Figure 1: Percentages of USMC Females Discharged (All-Cause) During the 1st Term Enlistment, by Injury During Recruit Training (N=2,715)



Odds ratios adjusted for age, race, and education

* p < 0.05

'Injury' - any injury during recruit training.

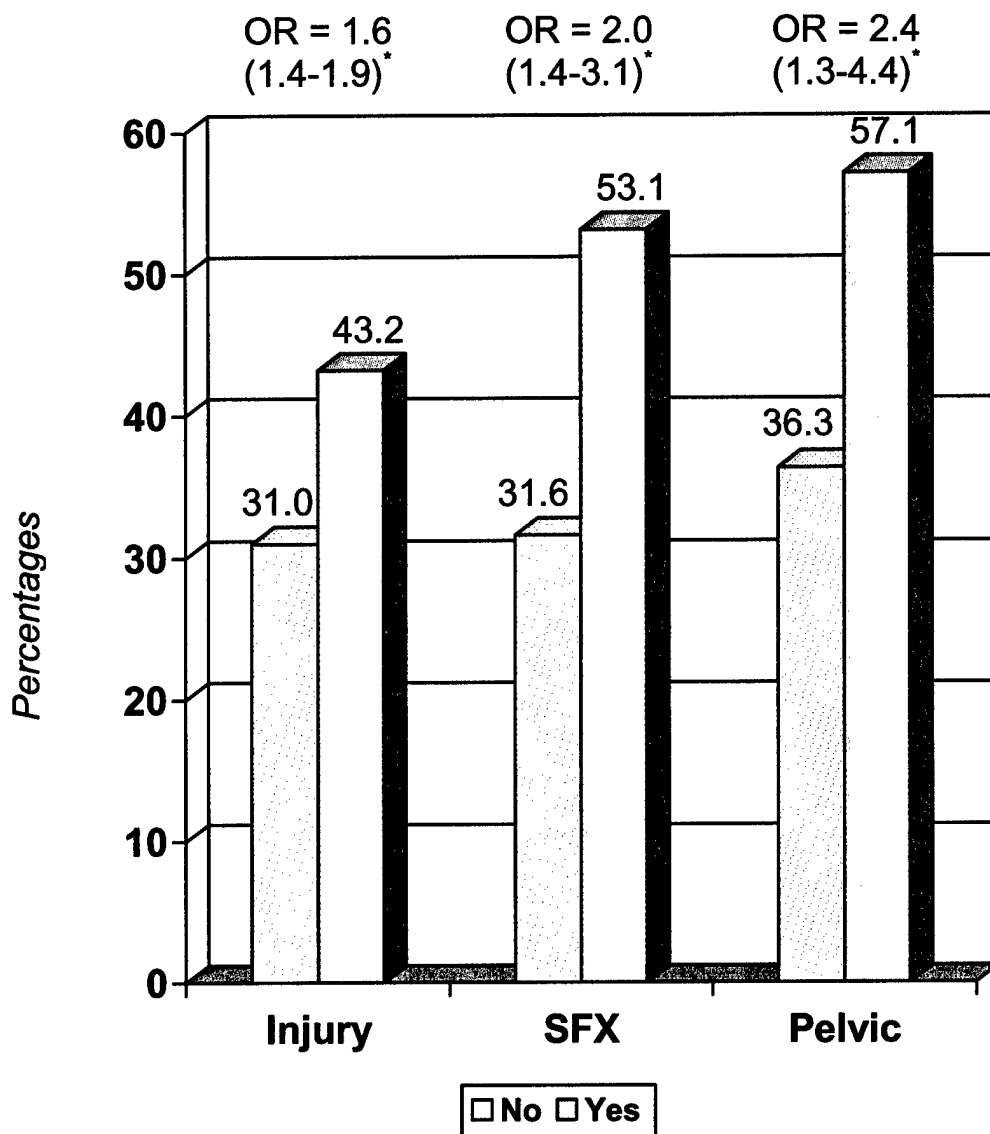
'SFX' - any stress fracture during recruit training.

'Pelvic' - pelvic or femoral stress fracture during recruit training.

Appendix D

Figure 2: Percentages of USMC Females Not Promoted to Corporal by End of the 1st Term Enlistment, by Injury During Recruit Training (N=2,715)

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Odds ratios adjusted for age, race, and education

* p < 0.05

'Injury' - any injury during recruit training.

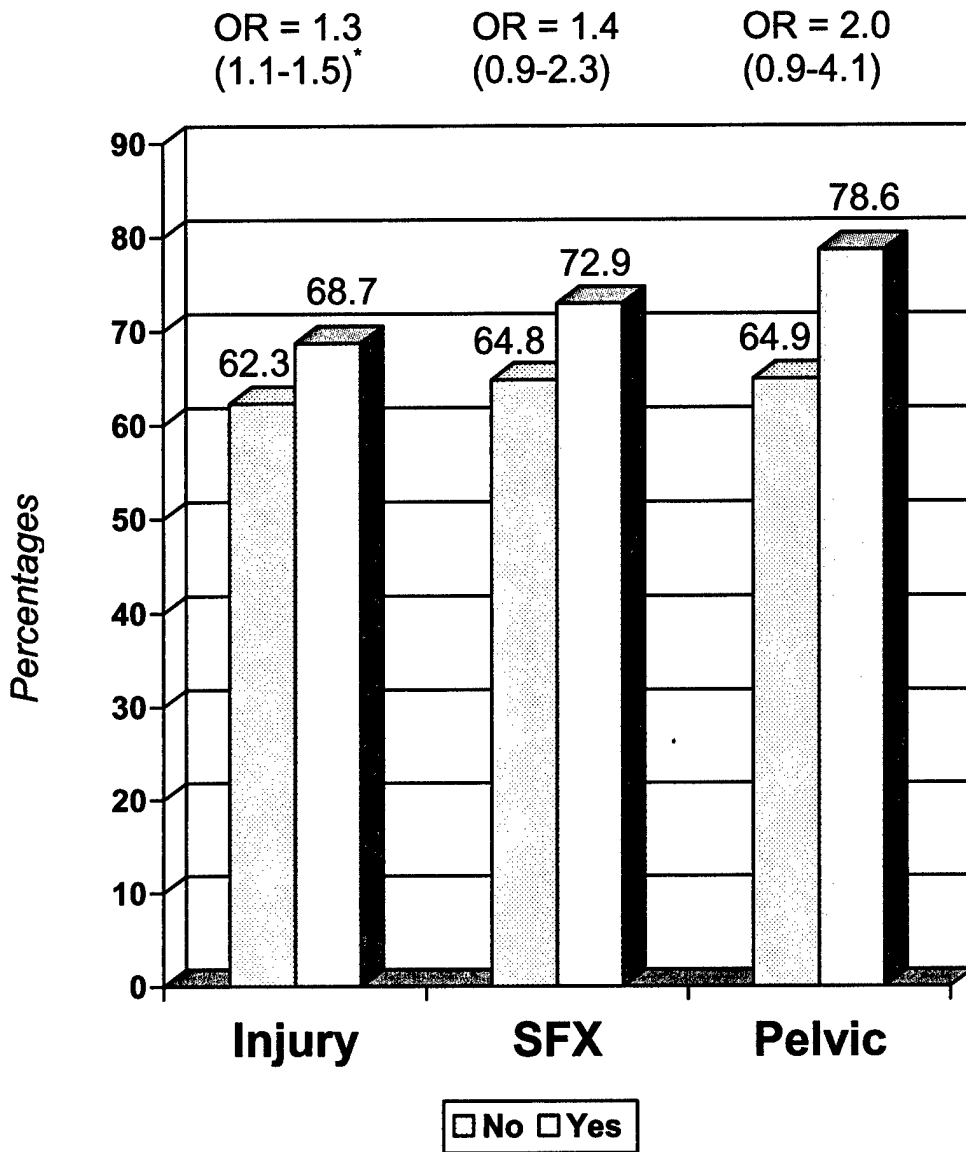
'SFX' - any stress fracture during recruit training.

'Pelvic' - pelvic or femoral stress fracture during recruit training.

Appendix E

Figure 3: Percentages of USMC Females Not Retained Past 1st Term, by Injury During Recruit Training (N=2,715)

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Odds ratios adjusted for age, race, and education

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'Injury' - any injury during recruit training.

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'Pelvic' - pelvic or femoral stress fracture during recruit training.