Stress Fractures, Active Component, U.S. Armed Forces, 2004-2010

Stress fractures are overuse injuries that occur in response to repetitive stresses (e.g., running, marching, jumping) to bones. The majority of stress fractures affect persons with normal bones who suddenly increase their physical activity. Clinically, stress fractures are characterized by localized pain of insidious onset that follows increased activity or training, worsens progressively with activity, and is relieved by rest.[1]

Intrinsic risk factors for stress fractures include increasing age, female gender, white, non-Hispanic race, and poor body mechanics.[2-5] Modifiable risk factors include body mass index (BMI) outside the normal range, poor fitness level, cigarette smoking, diet low in calcium, inappropriate footgear, and training characteristics (e.g., intensities, surfaces).[4] Participants in high-intensity training, such as athletes and military recruits, are at relatively high risk of stress fractures. Repetitive weight-bearing activities, particularly running and marching, are the most frequently reported causes of stress fractures.[6]

In general, the tibia, fibula, and metatarsals are the anatomical sites most frequently affected by stress fractures; however, stress fracture sites vary in relation to the precipitating activity.[7] In the U.S. military, stress fractures are significant obstacles to military operational effectiveness and substantial burdens to the military medical system.[4,8] Of particular note, among basic trainees, stress fractures account for more lost duty days and training recycles (i.e., delays in the completion of training) than any other training-related injury.[4]

This analysis summarizes numbers, incidence rates, and demographic and military correlates of risk of stress fractures among active component members of the U.S. Armed Forces from 2004 through 2010.

Methods:

The surveillance period was January 2004 through December 2010. The surveillance population included all individuals who served in the active component of the U.S. Armed Forces any time during the surveillance period. All data used for analyses were derived from records of hospitalizations and outpatient encounters that are routinely maintained in the Defense Medical Surveillance System (DMSS) for health surveillance purposes.

For this analysis, all medical encounter records that included diagnoses of stress fractures of the tibia/fibula, metatarsals, femoral neck, femoral shaft, pelvis, or other bone (ICD-9-CM codes: 733.93-733.98) were ascertained. Incident cases were defined as a hospitalization with a stress fracture-specific diagnosis code in any diagnostic position; or as two outpatient encounters at least 14 days but less than 180 days apart that included the same stress fracture-specific diagnosis code. Each individual could be considered an incident case only once during any 180-day interval.

Results:

During the seven-year surveillance period, there were 31,349 incident stress fractures (rate: 3.24 per 1,000 person-years [p-yrs]) among active component members. The overall incidence rate was approximately 18 times higher among recruits (43.75 per 1,000 p-yrs) than non-recruits (2.39 per 1,000 p-yrs) **(Figure 1)**.

Among recruits, annual incidence rates of stress fractures (overall) declined by 30 percent from 2005 (52.45 per 1,000 p-yrs) to 2010 (36.37 per 100,000 p-yrs). Among non-recruits, rates of stress fractures were relatively low and stable throughout the period **(Figure 1)**.

Among military members overall, the anatomic sites most frequently affected by stress fractures were "other bones" (n=12,975; 41.4%), tibia/fibula (n=12,112; 38.6%), and metatarsals (n=4,460; 14.2%). The anatomic distributions of stress fractures were similar among recruits and non-recruits **(Figure 2)**.

Among both recruits and non-recruits, rates of stress fractures of "other bones" peaked in 2007 and then sharply declined through 2010 **(Figure 3)**. Among recruits, rates of tibia/fibula fractures markedly decreased from 2004 through 2008, and rates of metatarsal fractures declined from 2005 through 2008. In contrast, among non-recruits, rates of

Figure 1. Incident cases and incidence rates of stress fractures among recruits and non-recruit active component members, U.S. Armed Forces, 2004-2010

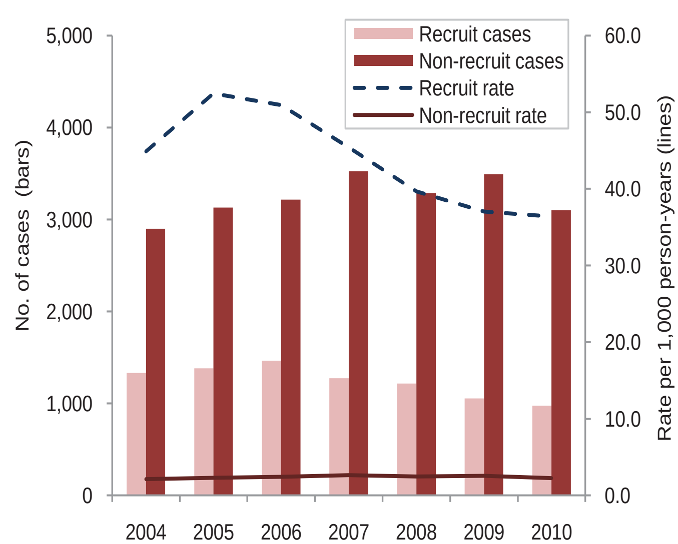
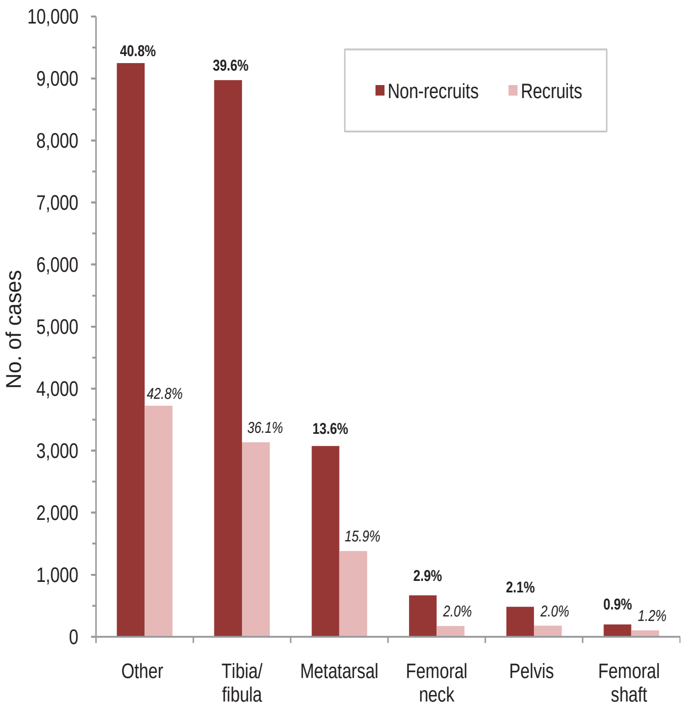


Figure 2. Number and percent distribution of incident stress fractures, by anatomical location, among recruit and non-recruit active component members, U.S. Armed Forces, 2004-2010



tibia/fibula and metatarsal fractures were relatively stable throughout the period **(Figure 3)**.

Tibia/fibula stress fractures

During the surveillance period, there were 3,137 and 8,975 incident tibia/fibula stress fractures among recruits (overall rate: 15.78 per 1,000 p-yrs) and non-recruits (overall rate: 0.95 per 1,000 p-yrs), respectively. Tibia/fibula stress fracture rates sharply increased with age among recruits and markedly decreased with age among non-recruits **(Table 1)**. Among both recruits and non-recruits, tibia/fibula stress fracture rates were more than twice as high among females than males **(Table 1)**.

Among non-recruits, tibia/fibula stress fractures rates were more than twice as high in the Army than any other Service. However, among recruits, tibia/fibula stress fracture rates were much higher among Marines than other Service members **(Table 1)**. During the surveillance period, the Marine Corps Recruit Depots at San Diego, CA, and Parris Island, SC, and the Naval Training Center at Great Lakes, IL, each accounted for approximately 20 percent of all tibia/fibula stress fractures among U.S. military recruits **(Table 2)**. Of note, beginning in 2004, rates of tibia/fibula stress fractures declined by more than 60 percent among Marine recruits (through 2009) and 80 percent among Navy recruits (through 2008). In contrast, rates of tibia/fibula stress fractures markedly increased among Air Force recruits (through 2009) and were relatively stable among Army recruits throughout the surveillance period **(Figure 4)**.

Table 1. Incident cases and incidence rates of stress fractures of the tibia/fibula among recruit and non-recruit active component members, U.S. Armed Forces, 2004-2010

	Non-recruits			Recruits		
	No.	%	Rate[a]	No.	%	Rate[a]
Total	8,975	100	0.95	3,137	100	15.78
Age						
<20	1,606	18	2.51	1,323	42	12.08
20-24	3,404	38	1.06	1,283	41	17.73
25-29	1,959	22	0.93	363	12	27.07
30-34	1,032	11	0.74	145	5	44.58
35-39	639	7	0.55	23	1	92.60
40+	335	4	0.37	.	.	.
Gender						
Male	6,173	69	0.76	2,219	71	13.21
Female	2,802	31	2.06	918	29	29.80
Service						
Air Force	776	9	0.34	250	8	7.80
Army	6,031	67	1.71	951	30	12.44
Marine Corps	908	10	0.78	1,301	41	26.41
Navy	1,229	14	0.54	604	19	15.99
Coast Guard	31	0	0.12	31	1	9.53
Race						
White, non-Hispanic	5,475	61	0.92	2,176	69	16.30
Black, non-Hispanic	1,622	18	1.01	329	10	12.28
Hispanic	1,107	12	1.12	297	9	14.81
American Indian/ Alaskan Native	135	2	0.82	77	2	17.75
Asian/Pacific Islander	435	5	0.96	160	5	18.44
Other	53	1	0.73	50	2	12.73
Unknown	148	2	0.69	48	2	31.07
BMI at accession						
Underweight	205	2	1.34	122	4	27.56
Normal	4,319	48	1.14	1,613	51	15.14
Overweight	2,774	31	1.14	1,100	35	15.88
Obese	562	6	1.58	181	6	14.64
Unknown BMI	1,115	12	0.41	121	4	19.47

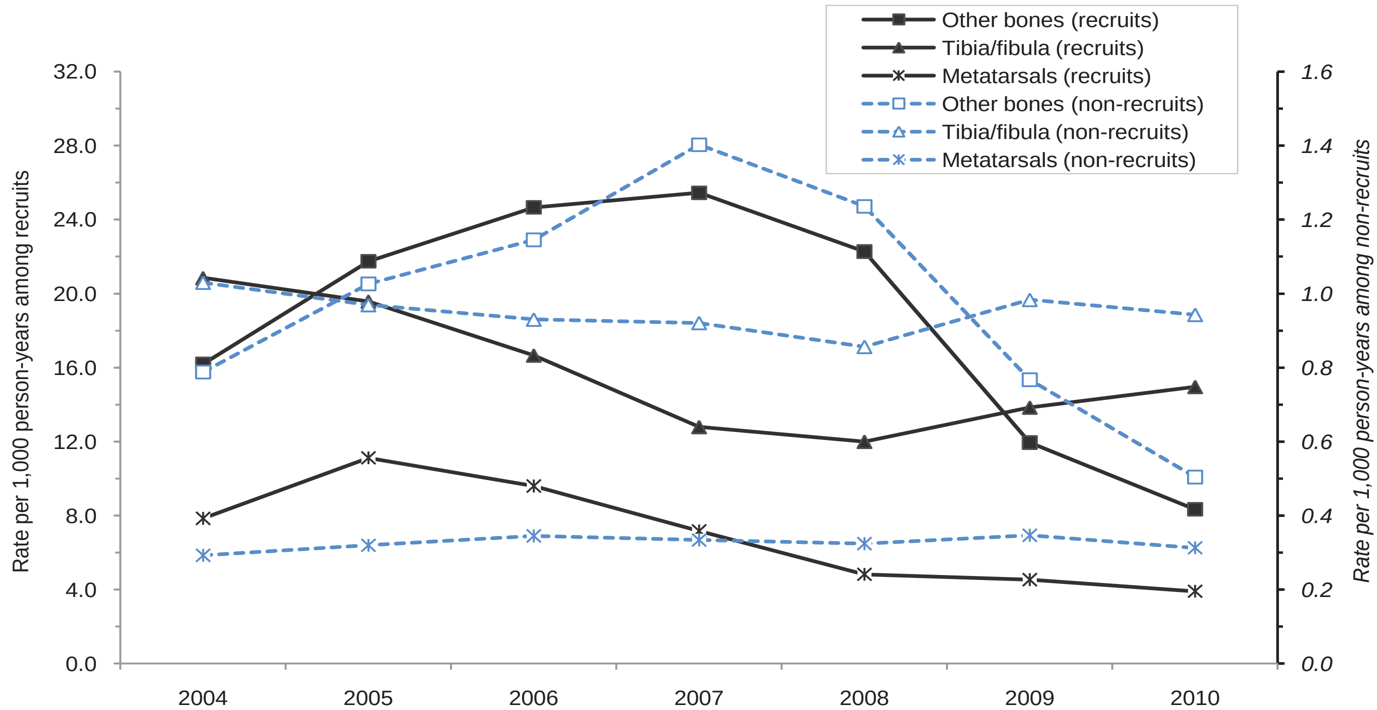
[a]Rates expressed as incident cases per 1,000 person-years of military service

Table 2. Incident cases and incidence rates of tibia/fibula stress fractures in recruits by training location, active component, U.S. Armed Forces, 2004-2010

Training location	No.	% total	Rate[a]	Incidence Rate Ratio (IRR)
MCRD San Diego	688	21.9	28.9	Ref
MCRD Parris Island	613	19.5	24.1	0.83
NTC Great Lakes	604	19.3	16.0	0.55
Ft. Benning	339	10.8	16.3	0.57
Ft. Leonard Wood	257	8.2	19.1	0.66
Lackland AFB	250	8.0	7.7	0.27
Ft. Jackson	202	6.4	8.0	0.28
Ft. Knox	128	4.1	15.8	0.55
CGTC Cape May	31	1.0	9.5	0.33
Ft. Sill	25	0.8	2.9	0.10

[a]Rates expressed as incident cases per 1,000 person-years of military service

Figure 3. Annual incidence rates of stress fractures, by selected anatomic locations, among recruits (left Y-axis) and non-recruits (right Y-axis) active component members, U.S. Armed Forces, 2004-2010



Finally, among recruits and non-recruits, crude rates of tibia/fibula stress fractures did not markedly vary across racial-ethnic subgroups. However, tibia/fibula stress fracture rates were much higher among recruits with BMIs indicative of "underweight" and slightly higher among non-recruits with BMIs associated with "obesity" **(Table 1)**.

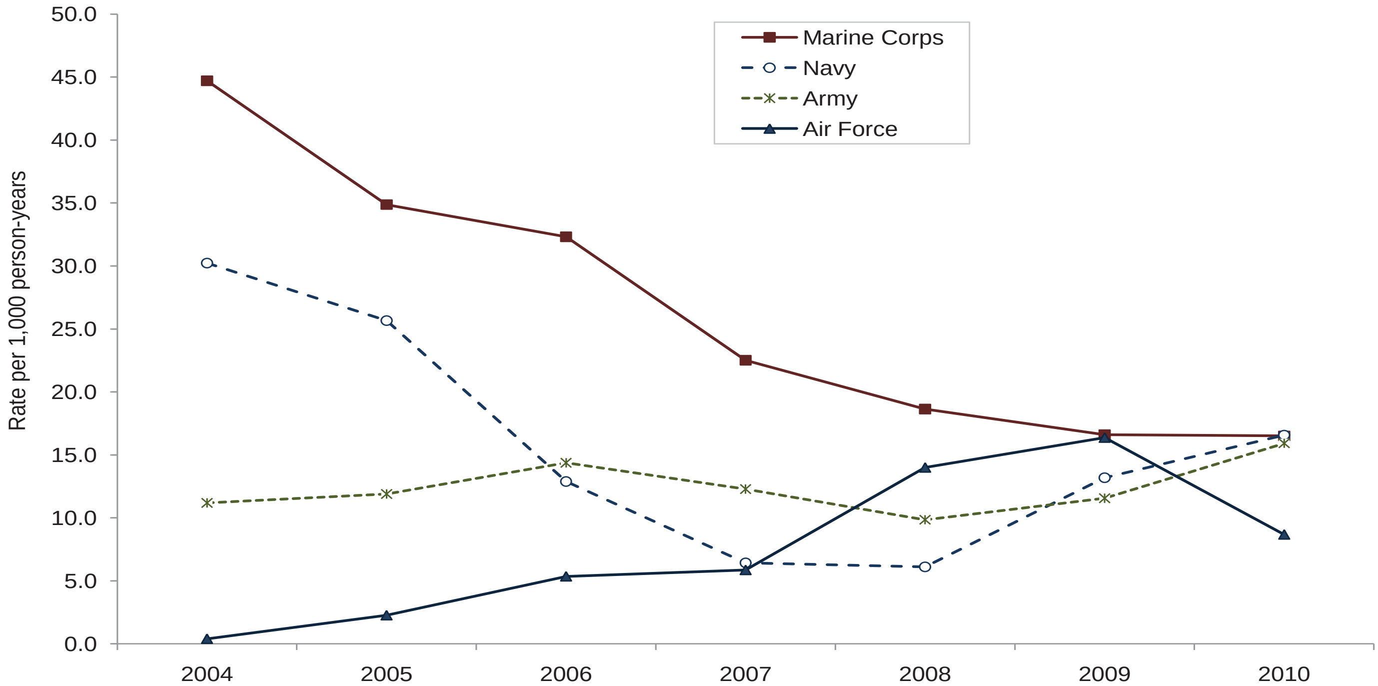
Editorial comment:

This report reemphasizes the fact that recruits are at much higher risk of stress fractures than more experienced military members. During the seven-year period reviewed for this report, annual stress fracture rates (all sites) were 15 to 23 times higher among recruits than non-recruits. Of note in this regard, rates of stress fractures among recruits (overall) decreased each year from 2005 through 2010. The decline was most apparent in relation to stress fractures of bones of the foot (metatarsals) and lower leg (tibia/fibula).

The findings of this report should be interpreted with consideration of several limitations. For example, in 2008, the ICD-9-CM code list expanded to enable more specificity in reporting the anatomic sites of stress fractures (i.e., pelvis, femoral neck, femoral shaft). Sharp declines in rates of stress fractures of "other bones" beginning in 2008 undoubtedly reflect, at least in part, the availability of more specific diagnostic codes. Also, the surveillance case definition used for this report relied exclusively on stress fracture-specific ICD-9-CM codes that were reported on administrative records of medical encounters in fixed (e.g., not deployed, at sea) medical facilities. Thus, there was no radiographic confirmation of the diagnoses, severities, or anatomic sites of the reported fractures. In addition, this report summarized stress fractures among active component members only. However, all reserve and National Guard members undergo recruit training; thus, it is likely that significant proportions of all stress fractures among U.S. military members affect reserve component members. Undoubtedly, the results presented here underestimate the actual numbers, military operational impacts, and health care burdens of stress fractures among U.S. military members. Also, the body mass indexes (BMIs) that were used for analyses in this report were those reported at the times of service members' accession to military service. Thus, in some cases, the BMIs at the times of incident stress fracture diagnoses may have differed significantly from those used for analysis. Finally, the effects of predisposing conditions for stress fractures were not accounted for in the crude (unadjusted) analyses conducted for this report.

Despite the limitations, there are informative and potentially useful findings of the analyses. For example, in 2004, rates of stress fractures of the tibia/fibula were much higher among Marine Corps and Navy recruits than those of the other Services. However, from 2004 through 2010, rates of lower leg stress fractures very sharply declined among Marine Corps and Navy recruits; of note, in 2010, rates of lower leg stress fractures were very similar among Marine Corps, Navy, and Army recruits. The decrease in lower leg stress fractures among Marine Corps recruits likely reflects a change in the recruit training schedule that was implemented in 2003. The revised schedule aimed to reduce injuries by increasing recovery time between intense physical training.

Figure 4. Annual incidence rates of stress fractures of lower leg (tibia/fibula) among recruits, by service, active component, U.S. Armed Forces, 2004-2010



Similarly, the decrease in lower leg stress fractures among Navy recruits likely reflects changes in recruit training since 2003; the changes included an increase in the minimum hours of sleep at night and a reduction of cumulative marching distance during recruit training. The changes were based on the findings of stress fracture prevention studies in the U.S. and experiences of other military forces. The changes have been linked to a decrease in attrition from Navy recruit training and reductions in stress fracture risk.[9,10] In contrast, the increase in lower leg stress fracture rates among Air Force recruits since 2005 may reflect changes in recruit basic training that were implemented in November 2005; the changes toughened recruit physical fitness standards and training and increased emphasis on deployment-related training (i.e., combat-specific activities, weapons training). Also, in 2008, the Air Force lengthened its basic training from 6½ to 8½ weeks. Of note, in 2010, the rate of lower leg stress fractures among Air Force recruits was lower than the rates among the recruits of the other Services. Together, the findings indicate that recruit training schedules can be designed to minimize stress fracture risk without compromising the military training mission.

Particularly among military recruits, stress fractures are significant obstacles to military operational effectiveness and substantial burdens to the military health system. Preventive interventions that have been found effective in research studies and lessons learned from the experiences of recruit training centers should be incorporated into recruit training schedules and practices. The effects of changes in training schedules and practices should be systematically monitored, and those that reduce injuries without compromising training should be widely implemented.

Reported by: CPT Dara Lee, MC, USA

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