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# Prior Knee Injury and Risk of Future Hospitalization and Discharge from Military Service

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**Background:** Athletic capability is paramount for survival in military basic training and successful service. Orthopedic conditions are common reasons for hospitalization and premature discharge of military recruits. Medical fitness for military service is determined through a medical examination. Individuals medically disqualified may receive a waiver to enter the service on a case-by-case basis. This study was carried out to determine how individuals with a medical waiver for knee problems compared to recruits without a history of knee injury regarding hospitalization and military discharge.

**Methods:** Two hundred eighty-one enlisted recruits with a history of a waiver for a knee condition were considered high risk. The comparison group was 843 recruits without prior knee pathology. Comparisons were made using frequency and chi-square analyses, relative risk estimates, and survival analyses.

**Results:** Individuals in the high-risk group were 1.4 (CI 1.0, 2.1) times more likely to be hospitalized for any diagnoses and 8.0 (CI 2.1, 29.9) times more likely to be hospitalized for a knee condition than those in the comparison group. Individuals with a knee waiver were 2.1 (CI 1.3, 3.5) times more likely to be prematurely discharged, and 14.0 (CI 4.6, 39.6) times more likely to be discharged for a knee-related condition than those in the comparison group.

**Conclusion:** Unfavorable outcomes were more likely in recruits disqualified initially and granted a waiver than in recruits without a history of knee injury. Military service requires intense physical activity; therefore, further research should be conducted to limit knee-related morbidity, especially in those with a prior history of knee injury.

**Medical Subject Headings (MeSH):** military medicine, military hospital, knee injuries, knee, patient discharge (Am J Prev Med 2000;18(3S):112-117)

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## Introduction

All uniformed military services depend on the recruiting and accession process to maintain the required military strength. One part of this process is a medical examination to determine medical fitness for military duty. When a recruit applicant is medically disqualified on entrance medical examination, a waiver may be granted. This process consists of additional medical record reviews and possibly a specialist examination, with a final determination by the respective service's central waiver authority. Recruits with a medical condition that existed before enlist-

ment, including those with waivers, who develop a significant clinical recurrence within the first 6 months of active duty, may be discharged with this condition because it existed prior to service (EPTS). After the initial 6 months on active duty, a formalized medical review board is required for a discharge based on a medical condition.

The loss of new recruits during initial training and first military assignment is costly in terms of dollars and military readiness. In 1995, there were 153,228 recruit accessions for the combined services, each costing the Department of Defense (DoD) at least \$25,000 (J. Larsen, TRADOC Deputy Chief of Staff Recruiting Office, and K. Cox, January 1998. Personal Communication). Five percent of these (approximately 7600) resulted in an EPTS discharge, amounting to a loss of nearly \$200,000,000. Identifying factors that contribute to the medical reasons for some of these early recruit losses have become a priority.<sup>1</sup>

Orthopedic conditions are among the more com-

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mon medical causes for an EPTS discharge, and knee conditions represent 11.3% of all such discharges.<sup>2</sup> Pre-existing knee conditions in the recruit population can be divided into those related to trauma and those unrelated to trauma. A history of knee trauma often involves injury to the menisci or the major joint ligaments. Some require surgical correction and some result in incomplete healing. Differing opinions exist among medical specialists as to whether there can ever be full recovery of the joint without sequelae, regardless of the re-examination and functional assessment results of the joint after rehabilitation.<sup>3-7</sup> Anterior cruciate ligament (ACL) insufficiency, meniscus damage, and meniscectomy are all known risk factors of osteoarthritis.<sup>8</sup>

Physical activity demands are high in all of the uniformed services. This is particularly true in the initial 6-month training period, where daily intense exercise and vigorous training are mandated. Thereafter, service members must participate in organized physical fitness programs at least 3 times a week, and pass semiannual physical fitness tests.

This study examines whether military recruits who obtained a waiver for a prior knee ligament or meniscus condition (e.g., previous knee trauma) were more likely than recruits without such a waiver to have a significant medical outcome. The outcomes examined included hospitalization, EPTS discharge, disability discharge, and discharge for any reason.

## Materials and Methods

We conducted a retrospective follow-up study on individuals entering active duty between January 1995 and December 1996 as verified through accession data from the Defense Manpower Data Center (DMDC). The high-risk group was defined as enlisted recruits in the Army, Air Force, and Navy who, based on individual service waiver authority data, obtained a waiver for a ligamentous or meniscal knee injury in 1995. Although a waiver was obtained in 1995, the recruit may not have entered active duty until 12 months after having received the waiver. Only initial enlistments were used. The case definition excluded individuals with waivers for anterior knee or patellar pathology, Osgood-Schlatter disease, congenital abnormalities, infections, rheumatic conditions, and nonspecific knee symptomatology (i.e., unspecified knee pain). Recruits without evidence of prior knee pathology (the comparison group) were randomly selected from DMDC data and matched in a 1:3 ratio on the following: service (Air Force, Army, Marines, Navy), gender, race/ethnicity (Caucasian, African American, other), age within 1 year, and year and month of entry into training.

The high-risk and the comparison populations were followed from entry into basic combat training through June 1997 for outcomes of hospitalization and discharge, resulting in follow-up times from 6 months to

**Table 1.** Distribution of knee diagnoses waived in the high-risk group

	Army	Navy/ Marines	Air Force	Total
Surgical correction	100	93	38	231
Anterior cruciate ligament	69	71	36	176
Collateral	2	1	1	4
Meniscectomy	2	3	1	6
Other/unspecified	27	18	0	45
Ligament injury	13	27	0	40
Other/unspecified	2	7	1	10
Total	115	127	39	281

30 months, depending on the date of entry. All outcomes were weighted equally.

Medical endpoints were analyzed separately by knee and nonknee-related outcome. Knee hospitalizations, knee EPTS discharges, and knee disability discharges included any knee diagnosis, ipsilateral and contralateral, without restrictions. Arthroscopic knee procedures in 1995 and 1996 were considered inpatient procedures. In 1997, only those with more than a 1-day admission were counted as inpatient procedures. Only the first knee hospitalization was counted when multiple admissions for knee pathology were listed. No specific breakdown of knee diagnoses in the EPTS discharge data is possible for the first 18 months of the study, so all knee-related discharges were counted as outcomes. Because disability data were coded using less specific Veterans Administration Schedule for Rating Disability (VASRD) codes, all knee-related disability discharges were included.

For overall hospitalizations, the first admission was used as the endpoint. Obstetrical and dental hospital admissions were excluded. Time to hospitalization was calculated in days from DMDC entry date to first relevant hospitalization date. Time to discharge was calculated in days from DMDC entry date to DMDC loss date.

Frequency analysis and chi-square analysis were used to evaluate the outcomes of hospitalizations, EPTS discharges, disability discharges, and combined outcomes. Relative risks (RR) with 95% confidence intervals (CIs) were calculated for hospitalization, EPTS discharge, and combined outcome results. The non-parametric Kaplan-Meier (product limit) method was used to estimate the survival function with respect to the outcomes already mentioned. Log-rank, Wilcoxon, and log-likelihood ratio tests were used to compare the probability of survival between the high-risk group and the comparison population. A *p* value less than 0.05 was considered statistically significant.

## Results

Both the high-risk (*n* = 281) and comparison (*n* = 843) groups were similar to the overall recruit population;

**Table 2.** Hospitalization of recruits at risk and comparison population

	High risk, % (N = 281)	Low risk, % (N = 843)	RR	95% CI
Hospitalizations for any diagnoses	12.5 (n = 35)	8.7 (n = 73)	1.4	1.0, 2.1
Hospitalizations for any knee diagnosis	2.9 (n = 8)	0.4 (n = 3)	8	2.1, 29.9
Proportion of all hospitalizations with a knee diagnosis	22.9	4.1		

CI, confidence interval; RR, relative risk.

14%, 40%, and 46% were in the Air Force, Army, and Navy, respectively. This compared to 18%, 36%, and 46%, respectively, for all recruits in 1995. The study population was 85% male and over 80% Caucasian. Average age for recruits with a knee waiver was 20.8 years; for those without a waiver it was 20.5 years. In addition to being waived for a knee condition, 82% of those at high risk had evidence of prior invasive knee procedures on review of the waiver data (Table 1).

The first medical outcome examined was hospitalization. Of the 281 recruits with knee waivers, 35 (12.5%) were hospitalized for any cause. Eight (2.9%) were admitted with a knee diagnosis, representing 22% of those hospitalized for any diagnoses. Of the 843 controls, 73 (8.7%) were hospitalized for any diagnosis, and three (0.4%) were admitted with a knee diagnosis; 4% of hospitalized controls had a knee diagnosis. The relative risk of admission for the high-risk group for any diagnosis was 1.4 (95% CI 1.0, 2.1); for a knee-related admission it was 8.0 (95% CI 2.1, 29.9) (Table 2). Hospitalization rates for nonknee-related diagnoses were similar for both groups: 9.6% of the recruits at risk and 8.3% of the comparison group.

The second medical endpoint analyzed was EPTS discharge. Of the 281 recruits at high risk, 25 (8.9%) resulted in such an entry discharge, and 18 (6.4%) for a knee-related condition. Seventy-two percent of discharges (18 of 25) among recruits with knee waivers resulted from knee-related pathology. Of the 843 in the comparison group, 35 (4.2%) had an EPTS discharge, and four (0.5%) for a knee diagnosis. The proportion in the comparison group with a knee-related discharge was 11.4% (4 of 35). The relative risk of discharge for any diagnosis for the high-risk group was 2.1 (95% CI 1.3, 3.5); for a knee-related discharge it was 14.0 (95% CI 4.6, 39.6) (Table 3).

The third medical endpoint analyzed was disability discharge. There were only four disability discharges

identified, all of them Caucasian Army individuals in the comparison population. None had a knee diagnosis.

An analysis of the risk of experiencing any medical outcome—for example, hospitalization, EPTS discharge, and disability discharge—was performed. Fifty-eight recruits at high risk (20.6%) had at least one such medical outcome; 26 (9.3%) were knee related resulting in 45% (26/58) of these outcomes for cases being due to a knee diagnosis. Of 110 controls (13.1%) who had at least one such outcome, three (0.7%) were knee related. Only 5.5% (6 of 110) of the outcomes for controls were for knee diagnoses. The relative risk of having any medical outcome for any diagnosis for recruits with a prior knee waiver was 1.6 (95% CI 1.2, 2.1), and 13.0 (95% CI 5.4, 31.3) for knee-related medical outcomes (Table 4). Nonknee medical outcomes were similar with 11.4% for those with and 12.3% for those without a knee waiver.

Any discharge was the endpoint used for the overall survival analysis. No difference was found between the high-risk waiver group and the comparison group ( $p = 0.50$ ). The absence of a difference held in the Air Force and Navy ( $p = 0.61$  and  $0.31$ , respectively). Analysis by gender and race/ethnicity revealed no difference between the two groups.

A significant difference was found between Army recruits with and without a knee waiver ( $p < 0.03$ ). Those with a waiver had a higher and earlier probability of attrition within the first 90 days. The probability of discharge in the study period was 0.32 for Army recruits at risk and 0.23 for controls (Figure 1). Army data were then analyzed for possible demographic determinants of the difference in overall survival (retention on active duty). Our analysis suggested that Army men with knee waivers are less likely to be retained on active duty ( $p \geq 0.09$ ). There was a significantly reduced rate of retention (survival) for Army high-risk women and the respective comparison group ( $p < 0.02$ ) (Figure 2).

**Table 3.** EPTS discharges for recruits at risk and comparison population

	High risk, % (N = 281)	Low risk, % (N = 843)	RR	95% CI
EPTS discharge for any reason	8.9 (n = 25)	4.2 (n = 35)	2.1	1.3, 3.5
Knee EPTS discharges	6.4 (n = 18)	0.5 (n = 4)	14	4.6, 39.6
Proportion of all EPTS discharges with a knee diagnosis	72.0	11.4		

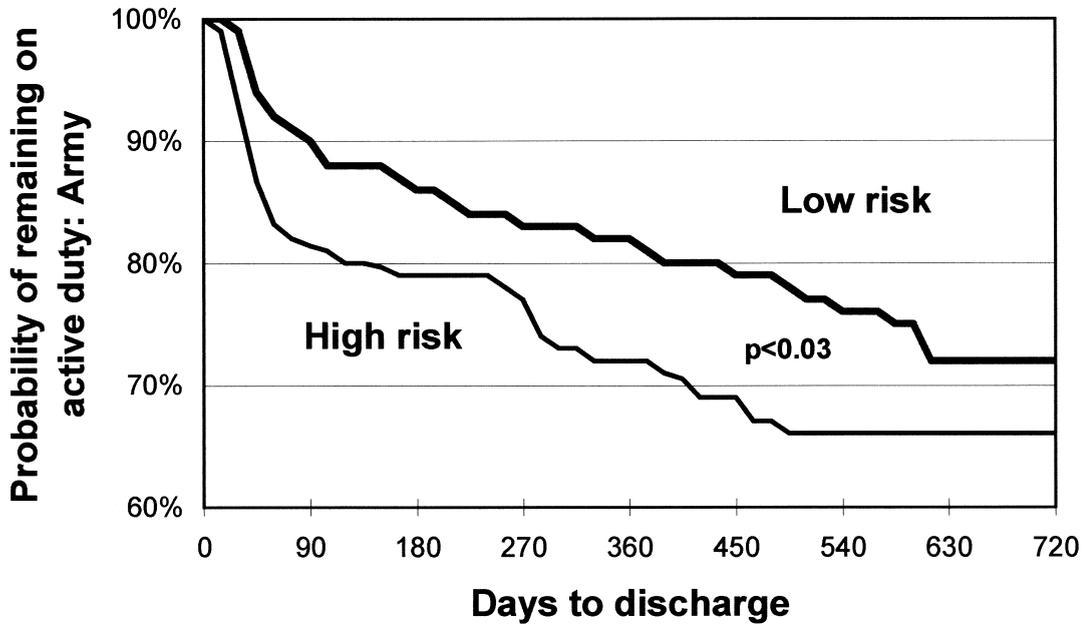
CI, confidence interval; EPTS, existed prior to service; RR, relative risk.

**Table 4.** Combined medical outcome<sup>a</sup> of recruits at risk and comparison population

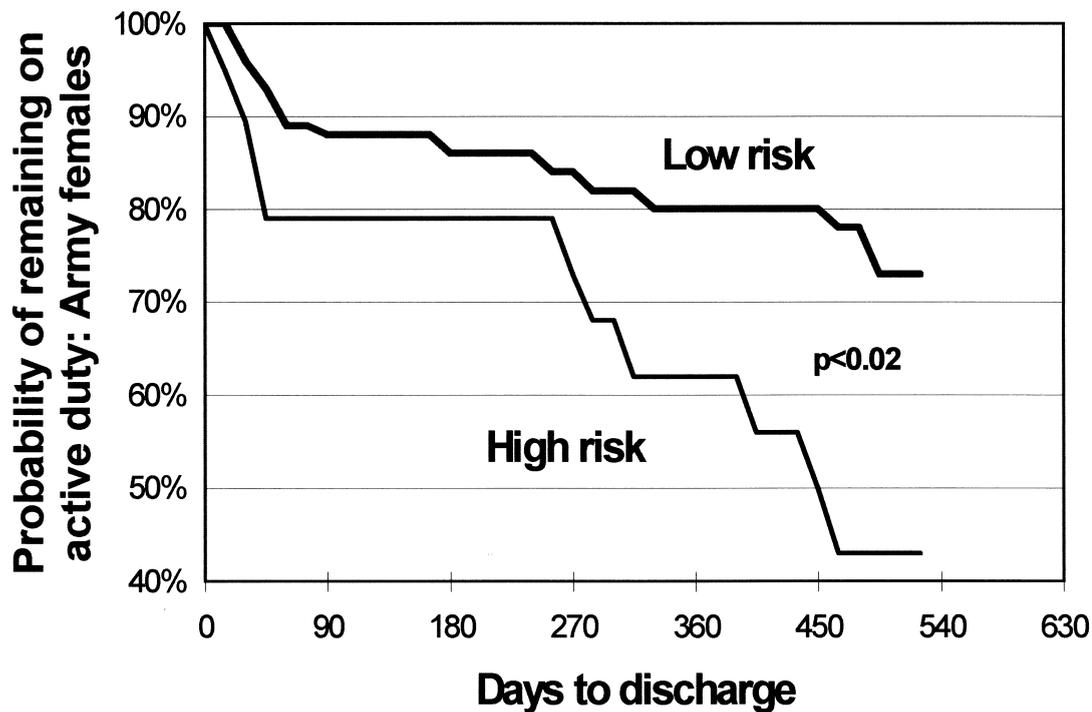
	High risk, % (N = 281)	Low risk, % (N = 843)	RR	95% CI
Combined medical outcome for any diagnoses	20.6 (n = 58)	13.1 (n = 110)	1.6	1.2, 2.1
Combined medical outcome with some knee diagnosis	9.3 (n = 26)	0.7 (n = 6)	13	5.4, 31.3
Proportion of all medical outcomes with knee diagnosis	44.8	5.5		

CI, confidence interval; RR, relative risk.

<sup>a</sup>Hospitalization, EPTS discharge, disability discharge.



**Figure 1.** Overall probability of remaining on active duty for Army high-risk recruits ( $n = 113$ ) and the comparison group ( $n = 339$ )



**Figure 2.** Overall retention of Army high-risk women ( $n = 19$ ) and the comparison group ( $n = 57$ )

Caucasian Army recruits at high risk also differed from the respective Caucasian Army comparison group ( $p = 0.02$ ). No differences were noted for other race categories or for age groups.

## Discussion

In this tri-service study, knee-related medical outcomes were more frequent for recruits with a knee waiver than those without such a waiver. Individuals receiving a waiver for a prior knee condition were 8 times as likely as the comparison group to experience a knee-related hospitalization and 14 times more likely to be discharged for a knee condition that existed prior to service. This increased risk of knee-related hospitalization and discharge is present despite a medical evaluation indicating a likelihood of good function, a reasonably high level of physical fitness necessary to enter the military, and a desire to perform. These high-risk individuals with prior knee trauma experienced knee-related adverse medical outcomes within the first term of service (less than 4 years after entry into the military), instead of functioning well until the onset of osteoarthritis many years later.

The intense physical nature of military basic training makes it an environment where optimal athletic capacity is crucial. Perhaps not all waived individuals had fully recovered from their initial injuries, or overuse of the contralateral knee resulting from trying to compensate for a weaker knee led to higher injury rates. Medical personnel may have treated those with a prior injury differently, resulting in faster discharge. It could also be that those with prior injury differed in health awareness or behavior toward seeking health care, which can lead to higher use of medical evaluations and interventions.

We found no difference between enlisted personnel with and without a knee waiver for a ligament or meniscus injury with respect to all-cause discharge in their military training and first assignment. The Army, when analyzed separately, showed a difference in overall retention between those at high risk and the comparison group. Most of this appears to be due to the higher discharge rate of Army women with a prior knee injury. However, the numbers involved were small. It could be that these women had differences from the controls that were not controlled for in this study, such as duration since initial injury before entry, degree of rehabilitation, level of fitness, body mass index, or other orthopedic conditions.

We assumed that the two groups did not differ in lifestyle, body composition, sport participation rates, co-morbidity, or behavior toward seeking health care. We also assumed that those with prior injury had all recovered equally well from their waived knee conditions before beginning military training.

There are several limitations to this study. The medical fitness standards for each service differ somewhat. This may cause a shift of recruits less physically fit toward some services. Waiver decisions are made separately for each service and are granted on an individual basis. It is unlikely, though, that the Army waiver authority would have applied different waiver standards to female and male recruits. The coding of waiver data does not reliably separate all ACL pathology from other entities; therefore, some cases were not identified for this study. Additionally, some recruits with prior injury may have been missed due to concealment. This misclassification of those at high risk into the comparison group would have biased our results toward the null. In addition, not all arthroscopic knee procedures would be captured as admissions in 1997 due to changes in hospitalization policy. This potential underreporting of knee-related outcomes would decrease the power of this study to find a significant difference.

Differences with respect to knee-related medical outcomes between those with a knee waiver and those without such a waiver were found in this young active population under the physical stress of military basic training. It is unlikely to be cost effective to change the current mass screening or waiver process for military recruit applicants with a prior knee ligament or meniscus injury and perhaps screen out many recruits who would do well on active duty. Further research is warranted, however, to examine the reasons for these differences and suggest possible strategies during training and military duty to limit knee-related morbidity in the military. Future studies should include an extension of the current study to 36 months of follow-up time for all study subjects. This would allow capture of more outcomes and strengthen the study findings. In addition, a complementary study evaluating recruits with anterior knee pathology and Osgood-Schlatter disease might be considered, given high outpatient utilization for these problems.

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The authors wish to thank Dr. Bruce Jones for his advice and review of this manuscript.

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