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KNEE-RELATED INJURIES AND DISABILITIES IN THE U.S. ARMY, 1980-1997

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13. ABSTRACT *(Maximum 200 words)*
Objectives: This report identifies predictors of occupational knee injury and knee-related disability; demonstrates that a series of case-control comparisons can be used to identify differences in the determinants of these outcomes; and demonstrates that data collected for administrative purposes represent a cost-effective resource for epidemiologic research.
Methods: Using the Total Army Injury and Health Outcomes Database (TAIHOD), we conducted separate case-control comparisons of occupational knee injury and knee-related disability discharge from active duty service.
Results: Among men and women, non-whites were at about 30% lower risk than whites for both outcomes. There was increasing risk of both injury and disability with increasing age for women, and for disability among men. Duration of service (positive) and pay grade (negative) were associated with both outcomes for men and women. Other risk factors differed for men and women by outcome, and the final models included different parameters for each gender. Exploratory analyses suggested interactions between demographic and occupational factors.
Conclusions: The differences between the final injury and disability models underscores the utility of separate case-control comparisons to identify risk factors for related outcomes. This study demonstrates the usefulness of large linked databases in epidemiologic research of occupational injury and disability.

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

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EXECUTIVE SUMMARY

Objectives: The major objectives of this report were to (1) identify predictors of occupational musculoskeletal disability, with a focus on knee-related outcomes; (2) demonstrate that a series of related case-control comparisons can be used to identify differences in the determinants of causally related outcomes (knee injury and knee-related disability); and (3) demonstrate that data collected for administrative purposes represent a cost-effective resource for analytical epidemiological studies.

Methods: Using data from the U.S. Army, we adapted Haddon's Matrix to the study of occupational disability by conducting separate case-control comparisons of occupational knee injury and knee-related disability discharge from active duty service. Each case-control comparison was nested within the population of Army personnel on active duty between 1980 and 1997. We developed multiple logistic regression models to analyze the independent contributions of sociodemographic and occupational characteristics to the risk of knee-related injury and disability. All models were stratified by gender.

Results: Among men and women, non-whites were at about 30% lower risk than whites for both knee injury and disability. There was increasing risk of both injury and disability with increasing age for women, and for disability among men. Duration of service (positive) and pay grade (negative) were also associated with both outcomes for men and women. Other risk factors differed for men and women by outcome, and the final models predicting injury and disability included different parameters for each gender. Exploratory analyses of possible effect modification suggested interactions between demographic and occupational factors.

Conclusions: These analyses were possible because of the availability of a large database containing occupational, demographic, and health information for a cohort of Army personnel. The wide range of data elements and the large, relatively diverse population enabled the evaluation of the separate and combined influence of sociodemographic and occupational characteristics on the risk of occupational injury and disability. This is among the first analytical epidemiological studies of its kind. The differences between the final injury and disability models suggests that the use of separate case-control comparisons to identify risk factors for related outcomes is a viable research method.

CHAPTER 1: INTRODUCTION

STATEMENT OF THE PROBLEM

Occupational injuries are responsible for more lost time from work, productivity, and working years of life than any other health condition in the United States (4, 31). The consequences of occupational injuries are manifold, and include physical, psychological, and economic components for both the injured worker and the employer (21).

The musculoskeletal system is a major site for occupational injury (52). The National Occupational Research Agenda promulgated by the National Institute of Occupational Safety and Health includes musculoskeletal injuries as a focus area, reflecting growing recognition in the research community of the importance of this problem (47). While the majority of occupational musculoskeletal injuries heal successfully, some result in long-term or permanent disability. Extended periods of lost work time due to occupational disability add to the human and the economic costs for both the injured worker and the employer. Accordingly, investigations aimed at increasing the understanding of the risk factors for disabling occupational injury represent an important public health research concern.

Much of the research in the area of occupational injury and disability has relied on descriptive epidemiology. If the public health goal of prevention is to be realized, then there must be some movement towards analytical epidemiological investigations to help identify specific risk factors (57). The U.S. Army offers a unique opportunity to study determinants of occupational injuries and disabilities for both practical and methodological reasons. In particular:

- The wide variety of jobs in the Army enables the analysis of many risk factors, with the potential for identifying gradations in risk.
- Many military jobs are physically demanding, representing high risk for injury and disability.
- All injuries for which medical attention is sought are documented in central databases.
- Medical care is equally available to all Army personnel, thus removing variability in access to care as an alternative explanation for observed differences in reported injury rates across strata defined by sociodemographic characteristics.
- Large numbers of women and members of racial/ethnic minorities are employed by the Army, allowing for the investigation of demographic differences in risk.
- Many military jobs are also represented in the civilian sector. A sizeable proportion of the risk factors identified in the Army, therefore, should be applicable outside of the military setting.

OBJECTIVES

The overall objective of this report was to identify predictors of occupational musculoskeletal disability. We focused on knee-related outcomes because knee-related occupational disabilities are a large, growing, and costly problem both in the

Army and in the civilian sector (5, 51, 56). A second major goal of this work was to demonstrate that a series of related case-control comparisons can be used to identify differences in the determinants of causally related outcomes, specifically, knee injury and knee-related disability. This work was conducted using a large relational database, the Total Army Injury and Health Outcomes Database (TAIHOD). The database contains sociodemographic, occupational, and selected health information on all active duty personnel in the U.S. Army between 1980 and 1997 (7, 8). An ancillary goal of this research was to demonstrate that data collected for administrative purposes represent an efficient and cost-effective resource for analytical epidemiological studies.

OCCUPATIONAL RISK FACTORS FOR KNEE INJURY AND DISABILITY

Physical demands have been associated with knee injury and the subsequent development of knee disorders. These demands may be the result of occupational activities such as prolonged kneeling (33, 59, 62) or leisure activities such as running or participation in certain sports (40, 48). Work in the Army is physically demanding, both due to specific job requirements and because physical fitness training is an integral part of the military life. Since Army personnel are required to meet physical fitness standards, and are regularly tested to assure adherence to those standards, exercise and fitness training may be considered occupational activities in this population.

Most occupational knee injury studies have focused on one or two activities (e.g., kneeling, walking), or identified the longest job held (e.g., carpet layer, painter) as a surrogate for specific activities or workload. The TAIHOD has the advantage of including semiannual records of job assignments and standardized assessments of physical demands for each coded job for all members of the population, a marked improvement over the level of detail available in most studies (19). In addition, there is a great deal of diversity in occupations represented in the Army, with jobs ranging from clerical staff to heavy construction and infantry. This variability enables the assessment of differences in risk associated with jobs that are rated similarly with respect to physical demands, or jobs that have different levels of demand but include similar activities.

PILOT RESEARCH

Preliminary analyses focusing on subsets of the data included in TAIHOD suggested that, within the Army, the rate of hospitalization specifically for knee injury has been increasing, and that hospitalization rates for knee injuries differ by gender and job (5). In a pilot study of sociodemographic determinants of discharge from the Army for any knee-related disability, we observed that the risk of discharge for knee-related disabilities depended on gender, race, and age, and these characteristics interacted in a complex manner (58). In particular, as shown in Figure 1.1, the relative odds of discharge for any knee injury among enlisted women compared to men was dependent on race and age. In general, white women were at higher risk than white men, and non-white women were at lower risk than non-white men. Further, the shape of the relation between risk of discharge and increasing age depended on gender. Figure 1.2 shows that, with ages 23-27 years as the referent group, the risk among both white and non-

white men displayed a J shape, while the risk among both white and non-white women followed an inverted U shape.

Figure 1.1: Relative Odds of Discharge for Disabling Knee Injury among Enlisted Women Compared to Men, Stratified by Age (Quintiles) and Race.

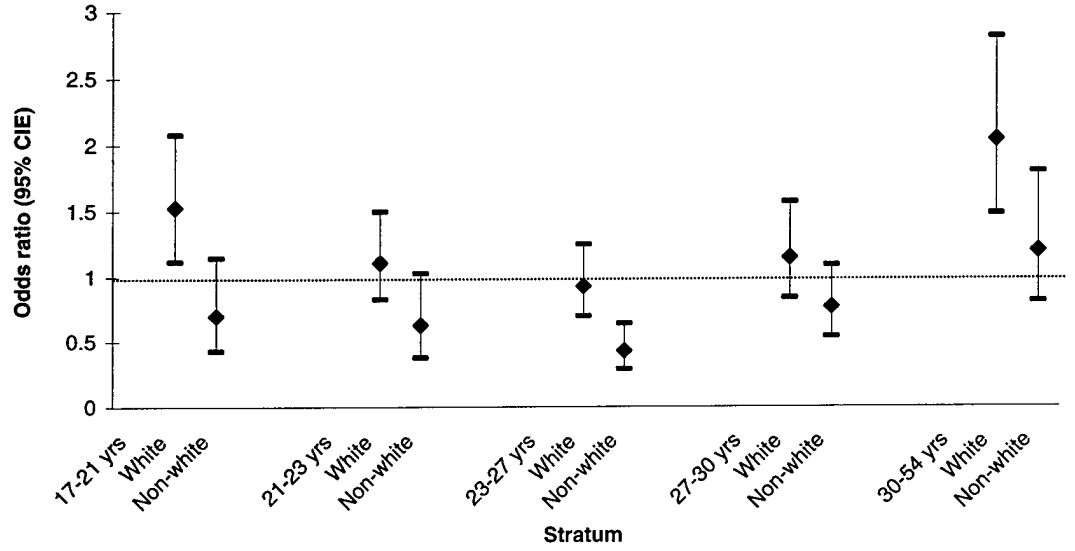
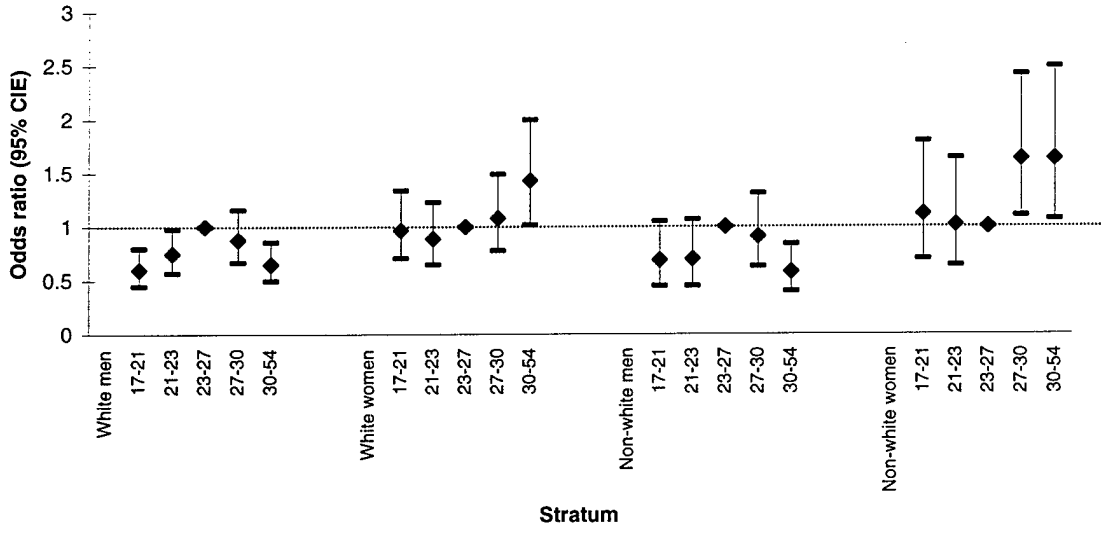


Figure 1.2: Relative odds of Discharge for Disabling Knee Injury with Increasing Age, Stratified by Sex and Race.



In another analysis, we found the risk of discharge for specific causes of disability also depended on sociodemographic characteristics. The three most common reasons for knee-related disability discharge accounted for 93% of cases. Among soldiers with these disability codes, the risk for women compared to men in models including race, age, and the interaction between gender and age ranged from 0.71 for impairment of the femur to 2.69 for impairment of the tibia/fibula (49).

In the third component of our pilot study, we found that specific tasks within job codes were associated with different risks, suggesting a useful strategy for grouping military occupations. For example, after controlling for gender, race, age, and other tasks required, men whose job description included kneeling were at 1.2 (task: kneeling while shoveling or lifting) to 2.5 (task: kneeling while filing) times the risk of discharge for any disabling knee injury compared to men whose job description did not include kneeling. The risks for women in jobs with the same tasks were 1.2 and 1.3 times higher, respectively, than women whose job descriptions did not include kneeling (64).

Possible reasons for the differences we observed in risk of discharge for knee-related disability include age, gender, and/or racial differences in job assignments; the distribution of tasks within job codes; physiology (i.e., likelihood of severe injury given certain physical demands); and procedural or social factors in granting disability discharge. This report built on the pilot study findings by accounting for disability type, job demands, and sociodemographic factors in multivariable models of risk of knee-related disability discharge. By also identifying risk factors for knee injury, we investigated the pathways by which knee injuries and related disabilities may occur.

MATERIALS AND METHODS

Conceptual Framework

In the early 1970s, Baker and Haddon proposed an approach for studying traumatic injuries that considers energy transfer between the environment and the human body as the major determinant of injury occurrence and severity. The focus of research using this framework is on avoiding energy transfer to prevent injuries, and on the reduction of the amount of energy transferred to reduce the severity of injuries (10).

The approach of Haddon and Baker is notable for its categorization of traumatic injury occurrence into three distinct phases: pre-event, event, and post-event. Each phase may be conceptualized as a separate opportunity for intervention. In the pre-event phase, efforts are directed at avoiding energy transfer between the environment and the body. Event-phase interventions reduce the amount of energy transferred should an event occur. Post-event phase interventions ameliorate the damage resulting from energy transfer. Using injuries resulting from falls as an example, pre-event phase interventions include the installation of grab bars and the use of non-slip flooring to reduce the likelihood of an event. Event-phase interventions include padding sharp corners or hard surfaces to reduce the amount of energy imparted on a falling body. Post-event phase interventions include ensuring the presence in the community of well-

trained and equipped emergency medical response teams to reduce the likelihood of long-term disability resulting from the injury (10).

In this report, we used case-control methods to explore risk factors for discharge from the U.S. Army for disability. In the Army, an individual is granted disability discharge when a medical evaluation or physical disability board determines that a person is incapable of performing his or her duty. "Disability," therefore, represents the culmination of an administrative process. Had we limited our attention to the determinants of disability discharge, then any factors we identified would contain a mixture of risks for disability, risks for the injury leading to disability, and factors that affect the administrative process for determining that a soldier is disabled. Using a conceptual framework similar to that of Haddon and Baker, we defined the "event" as the earliest detectable injury that could be related to the eventual disability. We posed a series of research questions, each of which was addressed by a distinct case-control comparison (described below) to separate the risk factors for injury from risk factors for disability.

Study Period

We addressed three related research questions by drawing separately defined samples of cases and controls from the same source population. The specific case and control definitions depended on the research question under consideration; these are detailed below. Each of the case-control studies was nested within the cohort of all enlisted personnel on active duty in the U.S. Army between 1980 and 1997. Thus, the study period began on January 1, 1980, and ended on December 31, 1997. Cases identified between January 1, 1984, and December 31, 1994, were eligible for inclusion in the study.

We used incidence density sampling to select controls. Controls were randomly sampled, within strata defined by gender, in proportion to the number of male or female cases, respectively, recorded in each 6-month interval between January 1, 1984, and December 31, 1994. The follow-up window for all cases and controls began on the latest of enlistment in the Army or January 1, 1980, and ended on the earliest of the case date, separation from the Army or December 31, 1997. The specific case-defining event, and thus the case date, depends on the research question under consideration.

Research Questions

The specific research questions addressed in this report follow naturally from the application of Haddon's approach to the consideration of disability discharge from the Army.

1. What are the risk factors for knee-related disability discharge from the U.S. Army? In Chapter 2, we present analyses of occupational and sociodemographic risk factors for knee-related disability discharge from the Army. These analyses identified factors that operated both before and after the injury that eventually led to the disability.

2. What are the risk factors for occupational knee injuries in the U.S. Army? We explore pre-event phase (pre-injury) risk factors for knee-related disability discharge in Chapter 3 by identifying risk factors for knee injury. We defined knee injuries as hospitalizations with any recorded knee-related diagnosis or procedure.

3. What are the differences between knee injuries that lead to disability discharge and injuries that do not lead to disability discharge? Chapter 4 presents a comparison of risk factors for knee-related disability discharge with risk factors for knee injury. This comparison entailed identifying which of the risk factors for injury were also determinants of disability discharge; which of the risk factors for injury were not determinants of disability discharge; and which determinants of disability discharge were not risk factors for injury.

Rationale for Using the Case-Control Approach

When an incidence density approach to sampling is used, then a nested case-control study, such as this one, can be thought of as a retrospective cohort study where samples from the risk set are drawn at a series of points in time. The risk set is defined as person-time at risk for the case-defining event. The exposure prevalence within the person-time comprising the risk set is compared with the exposure prevalence for the cases that have been identified up to the point in time when the risk set has been sampled.

It can be demonstrated that the prevalence odds ratio obtained from a case-control study nested within a fully enumerated cohort is mathematically identical to the risk ratio that would have been obtained from a cohort study analysis. The following is paraphrased from Rothman, 1986, pages 62-63(53):

In a dynamic cohort in steady state, disease incidence over some time interval, t, is

I_1=incidence among exposed= $a/(P_1t)$, and

I_0=incidence among unexposed=$b/(P_0t)$, and

RR=relative risk=I_1/ I_0

Using this notation, a and b are the number of exposed and non-exposed persons, respectively, who develop disease during the interval (cases), and P_1 and P_0 are the number of exposed and non-exposed individuals in the population that gave rise to the cases (Figure 1.3).

Figure 1.3. Distribution of Exposure and Disease in a Dynamic Cohort in Steady State

	Exposed	Not exposed
Disease present	a	b
Disease absent	c	d
	P_1	P_0

a=number of exposed persons who develop disease
b=number of non-exposed persons who develop disease
P_1=exposed population
P_0=non-exposed population

In the usual case-control study, cases are a sample of (a+b), those who develop disease during interval t, up to 100% of (a+b). Controls are a sample of P_1 and P_0, the cohort that gave rise to the cases. If k=the sampling fraction, c=the number of exposed controls, and d=the number of unexposed controls, then:

I_1=incidence among exposed=k(a/ct), and

I_0=incidence among unexposed=k(b/dt).

The value of k is generally unknown, but small relative to the size of P_1 and P_0. Since control selection is performed without regard to exposure status, k is the same for P_1 and P_0. When the case-control study is nested within a fully enumerated cohort, then k is known and I_1 and I_0 can be obtained directly, just as in a cohort study:

I_1=k(a/ct) and

I_0=k(b/dt), so

$RR=I_1/I_0=[k(a/ct)]/[k(b/dt)]=[a/ct]\bullet[dt/b]=ad/bc=OR$.

That is, when a case-control study is nested within a fully enumerated cohort, then k is known and the estimated RR is identical to the estimated OR.

While the results of the cohort study and the nested case-control study are the same, the implementation of the case-control study is logistically and analytically more efficient. The efficiency of the approach is due to the sampling of the population at risk. The increased efficiency is especially important if the outcome under study is rare, so that it would be otherwise difficult to obtain a sufficient number of cases for analysis. In addition, the case-control method is best employed when there are several potential exposures of interest. Both situations pertain in this study:

- Knee-related disability discharges from the Army are rare. Between 1980 and 1997, there were 10,000 knee-related disability discharges from the U.S. Army, or 0.4% of the source population of 2.5 million people.
- A number of risk factors for disability discharge have been suggested by the literature and by pilot research using the TAIHOD. Putative risk factors include

job title, job tasks, previous injuries, hospitalization history, and sociodemographic characteristics. It would be statistically and computationally inefficient to define exposed and non-exposed groups for follow-up based on the cross-classification of the population into categories based on these characteristics, since each sub-group would be relatively small and would experience relatively few events over the course of follow-up.

Data Sources

The TAIHOD is a relational database that was developed by LTC Paul Amoroso, M.D., of the U.S. Army Research Institute of Environmental Medicine (USARIEM) in 1994. The TAIHOD has been updated annually, and links demographic and occupational data on all Army personnel on active duty with databases tracking hospitalizations, lost work time injuries, disability determinations, and fatalities. In addition, Health Risk Appraisal (HRA) questionnaires are available for a subset of the population, and date from approximately 1990. All data files are linked by a unique study identifier. The TAIHOD population through 1997 consisted of 2.5 million individuals, with 12,158 deaths and nearly one million hospital admissions. The structure of TAIHOD is described in Appendix A.

Source Population. The source population for each case-control study included in this report comprises all enlisted personnel in the U.S. Army on active duty at any time between 1980 and 1997. Active duty personnel were identified by the presence of a record in the personnel database, and enlisted rank was based on pay grade as recorded in the personnel database. The source population included about 244,000 women and 1.8 million men.

Data Library. We constructed a data library consisting of records from the personnel, hospital, disability, safety and HRA files (Appendix A) for a sample of active duty enlisted personnel fulfilling the study inclusion criteria. Appendix B shows a schematic representation of the TAIHOD population, cast in case-control terms of the presence or absence of a knee-related disability discharge. The data library was constructed in the same terms, comprising separate samples of individuals discharged from the Army for knee-related disability (box one in Appendix B) and individuals not discharged for knee-related disability (box two in Appendix B).

Table 1.1 shows the eleven codes used in the disability database that indicate a disability broadly related to a knee problem. Individuals discharged for knee-related disability based on the selected codes were matched to the personnel file. The presence of a record in the personnel file in the same year as the discharge, or in the year prior to the discharge record, was used to indicate active duty status. We determined enlisted rank from pay grade recorded in the personnel file. All discharged personnel (N=9,634) with any of the knee-related disability codes who were on active duty at discharge, who were of enlisted rank, and who were not missing data for gender were included in the data library.

Table 1.1. Disabilities Included in Initial Case Definition, Based on Veteran's Administration System for Rating Disability (VASRD) Codes

Disability Name	Code
Recurrent subluxation or lateral instability of knee	5257
Impairment of femur[a]	5255
Impairment of tibia and fibula[b]	5262
Removal of semilunar cartilage	5259
Genu recurvatum	5263
Dislocation of semilunar cartilage	5258
Knee replacement	5055
Thigh amputation	5160
Ankylosis of knee	5256
Amputation with loss of extrinsic pelvic girdle muscles	5163
Amputation 1/3 of the distance from the perineum to the knee joint	5161

a: Includes malunion of femur with knee or hip disability.
b: Includes malunion with knee or ankle instability.

We drew a sample of individuals not discharged for knee-related disability from the personnel file. This group comprises a simple random sample, stratified by gender, from the population of all enlisted soldiers with a record in the personnel file. The sample contains an average of three soldiers without a knee-related disability discharge for each soldier discharged for knee-related disability in each year. In pilot research, we found many fewer women than men had been discharged for knee-related disability between 1980 and 1994 (860 women and 7,868 men). Since one of our analytical goals was to identify gender-specific risks for injury and disability, we used a control:case ratio of 6:1 for women and 1.5:1 for men. Oversampling women enabled gender-specific analyses for each of the research questions. The data library contained a total of N=18,977 controls. We drew separate subsamples of cases and controls from the data library for each of the contrasts defined by the research questions.

Case and Control Definitions

Question 1: What are the risk factors for knee-related disability discharge from the U.S. Army? The case and control definition for research question 1 parallels the definition used in the construction of the data library. We assembled an analytic subset from the data library consisting of a random sample of cases discharged from service for knee-related disability (box 1, Appendix B) and a random sample of controls from among those without a prior knee-related disability discharge (box 2, Appendix B).

We sampled men and women separately. The case series included all women who were discharged for knee-related disability and a self-weighted sample of 1,000 men. The sampling weights corresponded to the proportion of male cases recorded in each 6-month interval between 1980 and 1997. We included three controls per case from the data library for both men and women to ensure adequate numbers of cases and controls of both genders to conduct analyses stratified by gender. Pilot study

analyses demonstrated that gender was a strong effect modifier in determining the risk of discharge for knee-related disability discharge (58).

Question 2: What are the risk factors for severe knee injuries in the U.S. Army? The case series for the second research question comprised all first recorded knee-related hospitalizations, represented by boxes four and six in Appendix B. Knee-related hospitalizations were identified by the presence of any knee-related ICD-9-CM diagnosis or procedure code in a hospital record (Appendix C). We identified risk factors for knee injury by comparing soldiers with knee-related hospitalizations to those without knee-related hospitalizations (control series for research question 2), represented by box five in Appendix B. Soldiers discharged for knee-related disability with no knee-related hospitalization recorded in the database (box 3, Appendix B) were excluded from this analysis, since it is likely that these individuals did experience a knee injury prior to discharge from the Army.

Question 3: What are the differences between injuries that lead to disability discharge and injuries that do not lead to disability discharge? We attempted to separate pre-event from post-event risk factors for disability by comparing risk factors for disability discharge (question 1) and risk factors for injury (question 2). Controls for this analysis were defined as soldiers hospitalized for a knee problem, but not discharged for a knee-related disability. Since there were relatively few controls available for a quantitative analysis (box four in Appendix B), Chapter 4 presents a qualitative comparison of risk factors for injury with risk factors for disability. We also include a revised analysis plan for this research question.

SUMMARY

The TAIHOD is a rich data resource, containing a variety of occupational and health information on a large population. Administrative databases, such as this one, are increasingly being used for epidemiological research, and techniques for effectively using these data resources are needed. This report addresses questions of the validity and utility of administrative data for occupational disability research.

CHAPTER 2: RISK FACTORS FOR KNEE-RELATED DISABILITY DISCHARGE FROM THE U.S. ARMY, 1980-1997

INTRODUCTION

The U.S. Army offers a unique opportunity to study determinants of disabilities among occupational subgroups, for both practical and methodological reasons. In particular: 1) the wide variety of jobs in the Army enables the analysis of many risk factors, with the potential for identifying gradations in risk; 2) many military jobs are physically demanding, representing high risk for injury and disability; 3) large numbers of women and members of racial/ethnic minorities are employed by the Army, allowing for the investigation of demographic differences in risk; and 4) many military jobs are also represented in the civilian sector. Risk factors for occupational disability identified in the Army, therefore, should also pertain to civilian workers.

Occupational Musculoskeletal Disabilities

Although the majority of occupational musculoskeletal injuries heal successfully, some result in long-term or permanent disability. The Social Security Administration (SSA) defines occupational disability according to the presence and severity of functional impairment. Among 26,020 applicants for disability benefits in Pennsylvania during 1990, 40% had musculoskeletal problems. Of those, 30% were found to be work-related, representing 66% of all work-related claims to the Pennsylvania SSA during that year (14). The U.S. Army also determines disability status and awards financial benefits according to the presence and degree of functional impairment (20). For fiscal year 1994, 53% of all disability discharges from the Army were due to musculoskeletal conditions. The next most common cause of disability discharge, mental disorders, accounted for only 14% of disabilities (6, 55).

Knee problems represent a substantial proportion of musculoskeletal injuries and disabilities among both civilian and military workers. Physical demands have been associated with knee injury and the subsequent development of long-term knee disorders and disabilities. These demands may be the result of occupational activities such as sustaining static loads, lifting, and prolonged kneeling (33, 43, 59, 62). Leisure activities such as running and participation in sports have also been implicated in the development of knee injury and disability (40, 48).

Knee problems have also been reported to vary across sociodemographic groups. Feuerstein et al. found that the risk of discharge from the Army for any musculoskeletal disability was higher for women compared to men between 1990 and 1994, and that the risk of disability discharge was dependent on job code. Among these cases of disability discharge, knee impairments were the third most common reason for discharge (23). In a pilot study of sociodemographic determinants of discharge from the Army for any knee-related disability between 1980-1994, we observed that the risk of discharge for all knee-related disabilities and for specific causes of disability depended on sex, race and age, and these sociodemographic characteristics interacted in a

complex manner (49, 58). We also found that specific tasks within job codes conferred different risks for knee-related disability discharge, suggesting a strategy for grouping the thousands of military occupation codes. For example, after controlling for sex, race, age and other tasks required, men whose job description included kneeling were at 1.2 (task: kneeling while shoveling or lifting) to 2.5 (task: kneeling while filing) times the risk of discharge for any disabling knee injury compared to men whose job description did not include kneeling. The risks for women with the same job descriptions were 1.2 and 1.3 times higher, respectively, than women whose job descriptions did not include kneeling (64).

This chapter describes the results of a case-control study of risk factors for knee-related disability discharge from the U.S. Army. These analyses build on the pilot study findings by accounting for both job demands and sociodemographic factors, and by extending the study period through 1997.

MATERIALS AND METHODS

Data Sources

The Total Army Injury and Health Outcomes Database (TAIHOD) is a relational database that links demographic and occupational information on all active duty Army personnel with databases tracking hospitalizations, lost work time injuries, and disability determinations. A unique study identifier links all data files. The TAIHOD is updated annually, and currently consists of data for 2.5 million individuals, with 12,158 deaths and nearly 1 million hospital admissions. The structure of TAIHOD is described in Appendix A.

Source Population and Data Library

The source population for this study was all enlisted personnel in the U.S. Army on active duty at any time between 1980 and 1997. Active duty was defined as the presence of a record in the personnel database; enlisted rank was based on pay grade as recorded in the personnel database. The source population included about 244,000 women and 1.8 million men (Appendix A). We defined a data library consisting of all cases and a sample of controls fulfilling the study inclusion criteria, but selected a smaller set from the data library to comprise the analysis group for this study.

Case Definition

Cases were drawn from the disability database. After reviewing all disability codes used in the database, we identified eleven that indicate a functional disability related to a knee problem. Table 2.1 lists all disabilities included in the case definition based on the 11 selected knee-related Veteran's Administration System for Rating Disability (VASRD) codes.

Table 2.1. Disabilities and Case Counts, Based on Veteran's Administration System for Rating Disability (VASRD) Codes

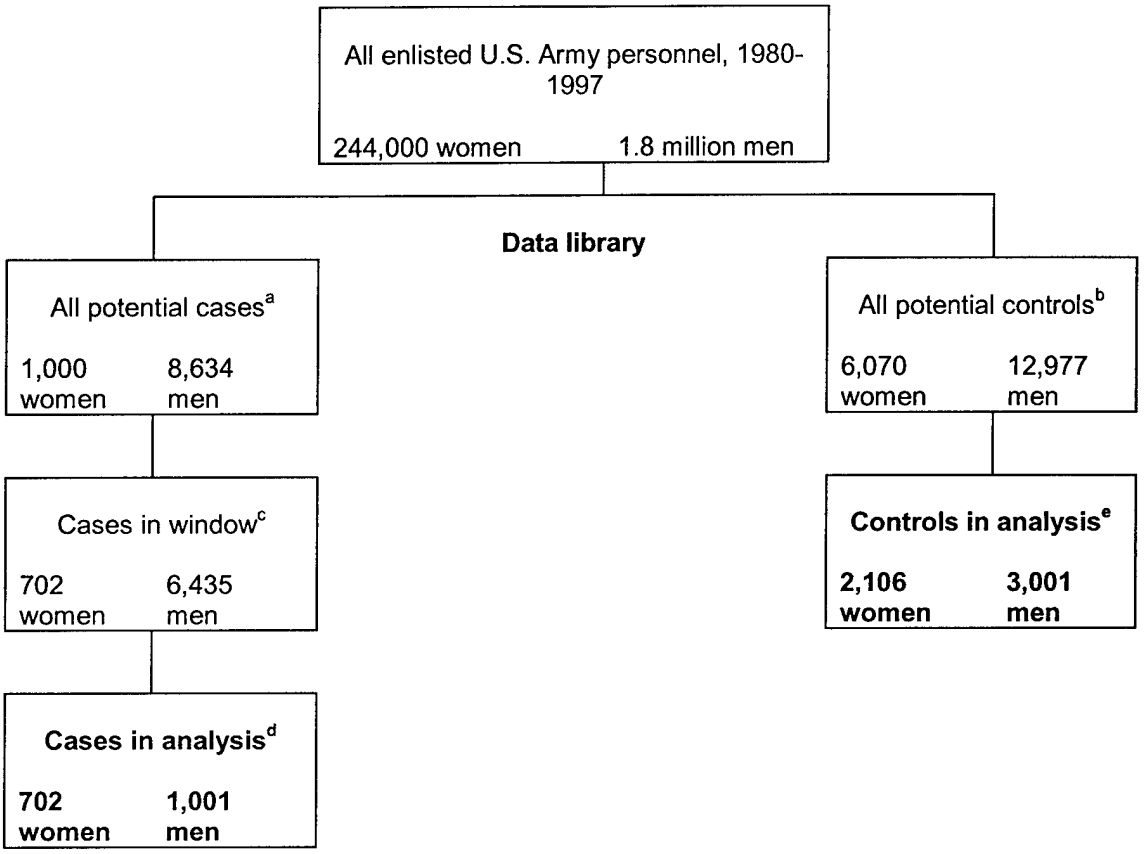
		Data Library				Analytic Subset			
		Women		Men		Women		Men	
Disability Name	Code	N	%	N	%	N	%	N	%
Recurrent subluxation or lateral instability of knee	5257	635	63.5	5,966	69.10	459	65.38	699	69.83
Impairment of femur[a]	5255	188	18.8	1,137	13.17	129	18.38	124	12.39
Impairment of tibia and fibula[b]	5262	116	11.6	961	11.13	71	10.11	105	10.49
Removal of semilunar cartilage	5259	44	4.40	450	5.21	32	4.56	58	5.79
Genu recurvatum	5263	6	0.60	23	0.27	3	0.43	5	0.50
Dislocation of semilunar cartilage	5258	7	0.70	52	0.60	1	0.14	3	0.30
Knee replacement	5055	1	0.10	5	0.06	1	0.14	0	0.00
Thigh amputation	5160	1	0.10	7	0.08	0	0.00	1	0.10
Ankylosis of knee	5256	0	0.00	25	0.29	0	0.00	6	0.60
Amputation with loss of extrinsic pelvic girdle muscles	5163	0	0.00	1	0.01	0	0.00	0	0.00
Amputation 1/3 of the distance from the perineum to the knee	5161	2	0.20	7	0.70	2	0.28	0	0.00
Total		1,000	100	8,634	100	702	100	1,001	100

a: Includes malunion of femur with knee or hip disability.
b: Includes malunion with knee or ankle instability.

Case records are the first recorded knee-related disability finding for enlisted soldiers who were on active duty in the regular Army at the time of the disability determination. We selected the first record for each soldier from the disability database with a reason for discharge listed as one of the 11 selected VASRD codes. Individuals with disability records coded as continuations on disability were not included among the cases. Continuation codes in the disability database indicate that a soldier had been initially placed on temporary retirement (temporary discharge) and was continued on temporary retirement after a re-evaluation of his or her medical condition. Since the database was initiated in 1980, the first recorded disability finding for a soldier may be a continuation on disability if that soldier was placed on temporary retirement before 1980, or if the first disability determination occurred after 1980 but was not properly recorded in the database.

We linked the remaining disability records with the personnel files from the year of the disability or, if necessary, from one year prior. Potential case records were excluded if there was no match in the personnel file for the disability year or the year prior, if the pay grade indicated officer status or if there was no information available for gender. There were a total of 1,000 enlisted women and 8,634 enlisted men with knee-related disability discharges who met the inclusion criteria for this study (Figure 2.1).

Figure 2.1. Construction of Data Library and Analytic Subsample of Cases and Controls



a. 100% sample of first records of knee-related disability discharge between 1/1/80 and 12/31/97; linked to personnel file; enlisted pay grade; known sex; no continuations on disability.
b. Incidence density sample from personnel file. Control:case ratio=1.5:1 for men, 6:1 for women. Enlisted pay grade, known sex.
c. 100% sample of cases recorded between 1/1/84 and 12/31/94.
d. 100% sample of women, self-weighted sample of men. Sampling weights = proportion of male cases recorded in a given calendar year.
e. Simple random sample, stratified by calendar year and sex. Control:case ratio=3:1 for both men and women.

Control Definition

The control series comprises a simple random sample, stratified by gender, from the population of all enlisted soldiers with a record in the personnel file for a given year. We sampled controls from each year in proportion to the number of cases recorded in that year to approximate incidence density sampling for the study period. We excluded any potential control with a knee disability recorded in any year prior to the year from which that control was sampled. We also excluded potential controls with a pay grade indicating officer status, or with missing data for gender. Overall, we included two controls for each case. Since we sought to investigate gender differences in risk of disability discharge, and since there were many fewer women than men in the case series, we used a control:case ratio of 6:1 for women, and a control:case ratio of 1.5:1

for men. There are a total of 6,070 women and 12,977 men among the controls included in the data library (Figure 2.1).

Eligibility Period

We restricted our analyses to cases recorded between January 1, 1984, and December 31, 1994, for two reasons. A preliminary review of the personnel and disability files indicated that the database may be less complete for the earliest years compared to the rest of the study period (data not shown). To reduce the amount of missing information and to reduce the likelihood of differences in data quality among cases and controls, we defined the beginning of the eligibility period as January 1, 1984. We truncated the right side of the eligibility period because a disability determination in the Army represents the culmination of an administrative process. This process includes medical examinations and physical disability board hearings, which take time to schedule and complete after the recognition of a possible physical disability. Preliminary analyses indicated that the average procedural interval, calculated as the time between first knee-related hospitalization (a surrogate for first knee injury) and disability discharge, is about two years (data not shown). We therefore closed the eligibility period at December 31, 1994, to allow for a sufficient procedural interval to elapse between injury and discharge. A total of 702 women and 6,435 men were discharged from active duty service during the eligibility window (Figure 2.1).

Analytic Subset

We selected a random subsample of both cases and controls from the data library. Cases comprise all 702 women and a self-weighted sample of 1,000 men from among the discharges recorded during the eligibility window of January 1, 1984, through December 31, 1994. Sampling weights for the men correspond to the proportion of all eligible male cases recorded in a given year. We selected a stratified random sample of three controls per case from the data library, by disability year, separately for men and women. The analytic subset includes a total of 5,107 controls (2,106 women and 3,001 men, Figure 2.1).

Occupational Exposures

Due to the longitudinal nature of the data, several preliminary steps were needed to identify the relevant job exposures for these analyses. These steps included a) evaluating job stability over the follow-up interval; b) revising obsolete job codes to follow a consistent coding scheme over time; c) mapping job codes to occupational tasks; and d) mapping job codes to Career Management Field (CMF) groups.

To evaluate whether or not job code and pay grade recorded at the end of follow-up (year of disability discharge for cases and frequency matched controls) represented the appropriate exposure information, we evaluated the stability of job codes recorded for all personnel included in the data library. We obtained a work history file containing

job code and pay grade, recorded in June and December, for every half-year during which a soldier was on active duty. We used these data to calculate the 6-month rate of change in Primary Military Occupational Specialty (PMOS) for cases and controls, defined as the number of times PMOS changed divided by the total number of 6-month intervals between 1980 and 1997 for which any PMOS was recorded. We calculated the rate of PMOS change separately for all cases and all controls, and for cases and controls stratified according to duration of service (1-33 months, $\geq$34 months). For cases discharged in 1983 and later, we also calculated the rate of PMOS change in the 4 years preceding discharge from service, 1) since job accommodations may have been made following injury and preceding discharge from service; or 2) the presence of an injury may slow the normal pattern of promotions and job changes.

There have been a number of revisions to the job codes assigned by the Army over the 17 years covered by TAIHOD (19). In order to map job codes to occupational tasks and CMF groups, we revised obsolete codes to follow a consistent scheme. We assessed the frequency distribution of PMOS separately for men and women, and revised the job codes that represented at least 1% of records in the data library (roughly the 50 most common PMOS) (64). The revised PMOS were coded according to the presence or absence of specific physical task requirements according to the Military Occupational Classification and Structure Manual (19), following the procedures developed by Williams (64). We also mapped all PMOS codes to the eleven CMF groups used by the Army for research and administrative purposes.

Statistical Methods

We used SAS version 6.12 (SAS Institute, Cary, NC) for data management and all analyses. Data quality and completeness were evaluated by reviewing univariate and bivariate frequency distributions in both the data library and the analytic subset. We assessed the scale and developed categorization schemes for continuous covariates based on the distributions among controls in the data library, since these observations are intended to represent the distribution of the various exposures and characteristics of interest in the source population.

Since the data included in TAIHOD were collected for administrative purposes, much of the coding is not useful for research. We used single predictor logistic regression models and comparisons of means and medians (t-tests, Mann-Whitney U-tests) in the analytic subset to identify terms with sufficient variability to be included as candidates in multiple logistic regression models of the probability of knee-related disability discharge. Due to the size of the samples of cases and controls being compared and, hence, a high degree of statistical power, we developed a decision rule to identify candidate terms that would be of both practical and statistical importance. Candidates for the multivariable models were required to have both an odds ratio (OR) demonstrating a 50% change from the null value of 1.0 ($OR \leq 0.67$, $OR \geq 1.5$) and $p \leq 0.05$ in single predictor models.

The goal of this study was to identify occupational risk factors for knee-related disability discharge from the Army while taking into account demographic characteristics that influence risk. Therefore, we first built models containing the demographic predictors of risk identified in preliminary analyses, then added work-related information in order to identify their independent effects, if any. We defined a new base model by removing terms that failed to retain significance according to the decision rule defined above. We individually reinstated each of the removed terms, and checked for confounding by these terms by calculating the percentage of change in the regression coefficients for all terms in the new base model. A 20% change in any coefficient was taken to indicate important confounding by a previously excluded covariate, and that term was added back into the final model (30). We used the likelihood ratio test to evaluate improvements in nested models.

We checked for effect modification by several characteristics identified a priori. These were age group, race, duration of service, and pay grade. We evaluated the goodness of fit of the final models using the Hosmer and Lemeshow statistic (30). All analyses were conducted separately for men and women.

RESULTS

Preliminary Analyses

Occupational Exposures. As shown in Table 2.2, the rate of job changes for cases and controls included in the data library was similar over the period of active duty. There were no differences in the rate of job change when controls were categorized according to duration of service. Cases with less than 33 months of service had a slightly lower job change rate (0.026 jobs/6 months) than cases with more than 34 months of service (0.043 jobs/6 months). The rate of job changes in the 3 years preceding disability discharge for the cases was similar to the rate of job change for all cases and for controls. Owing to the stability over time and to the similarity of the job change rate for cases and controls, all occupational exposures for these analyses were based on the PMOS recorded at the end of the follow-up period.

Table 2.2. Rate of PMOS[a] Change Among all Personnel Included in the Data Library with Available Work History Data

	PMOS change/6 months
Controls	
All (N=18,808)	0.038
<33 months service[b] (N=7,419)	0.038
120-414 months service[b] (N=7,556)	0.038
Cases[c]	
All (N=9,634)	0.034
<33 months service[b] (N=3,732)	0.026
34-120 months service[b] (N=3,776)	0.043
≤ 3 years of disability discharge	0.031

a. PMOS=Primary Military Occupational Specialty (i.e., job code).
b. Duration of service < 33 months represents lowest 2 quintiles among controls in the data library; 120-414 months represents quintiles 3-5.
c. Cases=knee-related disability discharge from the Army, 1980-1997.

Single Predictor Models. Table 2.3 shows the demographic and occupational characteristics of all cases and controls included in the analytic subset, stratified by gender. Among women, the age distribution was similar for cases and controls, although cases were slightly more likely to be in the two oldest quintiles of age. Cases were also more likely to be white, were generally less educated than controls, and were over-represented among the first two quintiles of duration of service. Perhaps as a consequence of their lower educational attainment or shorter service history, cases were more likely to be among the lower pay grades (E1-E3) compared to controls. The three most common CMF groupings for both cases and controls were support/administration, service/supply and healthcare. Cases were slightly over-represented among the electrical/mechanical equipment repair, electrical equipment repair, and craftsworker CMF groups. The physical tasks required of cases and controls were very much alike, reflecting their similarity with respect to the distribution of CMF groups. Cases were somewhat more likely to be in jobs associated with lifting weights of at least 100 pounds, and were slightly more likely than controls to be in jobs associated with sitting or standing.

Table 2.3. Demographic and Occupational Characteristics of Cases and Controls Included in the Analytic Subset[a]

	Women				Men			
	Cases (N=702)		Controls (N=2,106)		Cases (N=1,001)		Controls (N=3,001)	
	N	%	N	%	N	%	N	%
Age quintiles[b]								
17-20 years	119	16.95	341	16.21	113	11.31	525	17.5
21-22 years	119	16.95	395	18.77	190	19.02	546	18.2
23-25 years	133	18.95	483	22.96	249	24.92	612	20.40
26-32 years	206	29.34	568	27.00	267	26.73	662	22.07
33-60 years	125	17.81	317	15.07	180	18.02	655	21.83
Total	**702**		**2,104**		**999**		**3,000**	
Race								
Unknown	1	0.14	3	0.14	0	0	0	0
White	469	66.81	1050	50.0	719	71.83	1956	65.18
Black	198	28.21	916	43.49	232	23.18	878	29.26
Other	34	4.84	137	6.36	50	5.0	167	5.56
Total	**702**		**2,106**		**1,001**		**3,001**	
Marital status								
Unknown	9	1.28	21	1.0	13	1.30	54	1.80
Single	393	55.98	976	46.34	457	45.65	1314	43.79
Married	250	35.61	944	44.82	507	50.65	1556	51.85
Divorced/ separated	50	7.12	165	7.83	24	2.40	77	2.57
Total	**702**		**2,106**		**1,001**		**3,001**	
Education								
≤ 4 HS[c]	1	0.04	10	0.36	38	0.95	88	2.20
HS or GED[c]	585	20.8	1755	62.5	826	20.6	2473	61.8
≥ 1 year college	115	4.1	340	12.1	136	3.4	436	10.9
Alternate, unknown	1	0.04	1	0.04	1	0.02	4	0.10
Total	**702**		**2,106**		**1,001**		**3,001**	
Pay grade								
E1-E3	281	40.0	637	30.3	285	28.5	798	26.6
E4-E6	367	52.3	1200	57.0	580	57.9	1441	48.0
E7-E9	54	7.7	269	12.8	136	13.6	762	25.4
Total	**702**		**2,106**		**1,001**		**3,001**	
Duration of service[b]								
1-15 months	201	28.63	467	22.17	163	16.28	530	17.67
16-32 months	162	23.08	459	21.79	192	19.18	585	19.51
33-59 months	115	16.38	479	22.74	238	23.78	615	20.51
60-119 months	157	22.36	459	21.79	231	23.08	548	18.27
120-414 months	67	9.54	242	11.49	177	17.68	721	24.04
Total	**702**		**2,106**		**1,001**		**3,001**	
CMF[d]								
Support	192	27.39	781	37.12	90	9.05	351	11.72
Infantry	5	0.71	24	1.14	383	38.49	919	30.68
E-M repair	85	12.13	179	8.51	170	17.09	496	16.56
Service	116	16.55	283	13.45	85	8.54	321	10.72
Communications	102	14.55	274	13.02	108	10.85	312	10.42
Healthcare	116	16.55	377	17.92	48	4.82	179	5.98
Electrical	52	7.42	113	5.37	65	6.53	258	8.61
Technical	25	3.57	54	2.57	20	2.01	79	2.64
Craftsworkers	8	1.14	18	0.86	24	2.41	69	2.30
Non-occupational	0	0	1	0.05	2	0.20	11	0.37
Total	**701**		**2,104**		**995**		**2,995**	

	Women				Men			
	Cases (N=702)		Controls (N=2,106)		Cases (N=1,001)		Controls (N=3,001)	
	N	%	N	%	N	%	N	%
Physical tasks								
Lift/carry								
None	26	4.96	80	4.98	15	2.14	67	3.48
1-25 pounds	122	23.28	458	28.54	23	3.28	74	3.85
26-50 pounds	59	11.26	213	13.27	31	4.42	90	4.68
51-75 pounds	78	14.89	231	14.39	79	11.25	224	11.64
76-100 pounds	157	29.96	435	27.10	108	15.38	421	21.88
101-125 pounds	48	9.16	101	6.29	165	23.50	424	22.04
126-150 pounds	0	0	0	0	19	2.71	81	4.21
151-175 pounds	24	4.58	69	4.30	251	35.75	503	26.14
Raises 267 pounds	10	1.91	18	1.12	11	1.57	40	2.08
Total	**701**		**2,104**		**702**		**1,924**	
Push/pull								
None	389	74.24	1229	76.57	560	75.07	1533	74.42
< 130 pounds	77	14.69	223	13.89	65	8.71	182	8.83
≥ 130 pounds	39	7.44	107	6.67	100	13.40	289	14.03
Foot/pound force	19	3.63	46	2.87	16	2.14	43	2.09
Uses a wrench	0	0	0	0	5	0.67	13	0.63
Total	**524**		**1,605**		**746**		**2,060**	
Kneeling								
None	305	54.54	844	53.42	371	50.96	1195	58.93
While shoveling, lifting	54	10.36	143	9.05	301	41.35	609	30.03
While filing	14	2.69	34	2.15	5	0.69	8	0.39
For prolonged periods	148	28.41	559	35.38	51	7.01	216	10.65
Total	**521**		**1,580**		**2,028**		**728**	
Sitting								
None	118	22.52	466	29.03	28	3.75	100	4.85
Any	416	77.48	1139	70.97	718	96.25	1960	95.15
Total	**524**		**1,605**		**746**		**2,060**	
Standing								
None	251	47.90	838	52.21	112	15.01	452	21.94
Any	273	52.10	767	47.79	634	84.99	1608	78.06
Total	**524**		**1,605**		**746**		**2,060**	

a. Cases=knee-related disability discharge from the Army, 1984-1994.
b. Quintiles based on frequency distribution observed for all controls included in the data library.
c. HS=High school; GED=Graduate Equivalency Degree.
d. CMF=Career Management Field: support=support/administration; infantry=infantry/gun crews; e-m repair=electrical/mechanical equipment repair; service=service/supply; communications=communications/intelligence; electrical=electrical equipment repair; technical=technical/allied specialties; non-occupational includes trainees, prisoners, and patients.

Among men, the age distributions for cases and controls were very similar. Cases were slightly more likely to be in the third or fourth quintiles of age relative to controls. Male cases were more likely to be white, were less educated than controls, and were less likely to have achieved the highest enlisted pay grades (E7-E9). Male cases were most likely to be in the third or fourth quintile of duration of service, while male controls were most likely to be in the second or third quintile of duration of service. The most common CMF groups among both cases and controls were infantry/gun crews, electrical/mechanical equipment repair, and communications/intelligence. Again, following from the similarity in the distribution of cases and controls across CMF groups, the physical task requirements of cases and controls were very much alike. Cases

were slightly more likely to be in jobs associated with heavy lifting compared to controls (above 100 pounds), and were more likely to have jobs associated with standing compared to controls.

Table 2.4 displays the results of single predictor models of risk of discharge from the Army for knee-related disability among cases and controls with complete data for all terms included in the final models. There were 2,772 women (692 cases) and 2,574 men (682 cases) with complete data. These single predictor models were used to screen for candidate terms for inclusion, along with age and race, in multivariable logistic regression models. We defined as both practically and statistically significant those terms demonstrating a 50% change from baseline risk (OR $\leq$ 0.67, OR $\geq$ 1.5) with an associated p-value of $\leq$ 0.05.

Table 2.4. Single Predictor Logistic Regression Models of Probability of Discharge from the Army for any Knee-Related Disability[a]

	Women (N=2,772)			Men (N=2,574)		
	OR[b]	95% CI[b]	p[b]	OR[b]	95% CI[b]	p[b]
Age[c]						
17-21 years	1.0[d]	--	--	1.0[d]	--	--
21-22 years	0.88	0.65, 1.17	0.37	1.65	1.21, 2.24	0.002
22-25 years	0.79	0.60, 1.05	0.11	1.92	1.42, 2.59	<0.0001
26-32 years	1.04	0.80, 1.36	0.75	1.76	1.30, 2.38	0.0002
33-60 years	1.14	0.85, 1.53	0.39	1.26	0.91, 1.73	0.16
Race						
White	1.0[d]	--	--	1.0[d]	--	--
Nonwhite	0.49	0.41, 0.59	<0.0001	0.72	0.60, 0.88	0.001
Married						
No[e]	1.0[d]	--	--	1.0[d]	--	--
Yes	0.68	0.57, 0.81	<0.0001	0.93	0.78, 1.11	0.41
Duration of service[c]						
1-15 months	1.0[d]	--	--	1.0[d]	--	--
16-32 months	0.84	0.66, 1.07	0.16	1.16	0.87, 1.54	0.32
33-59 months	0.56	0.43, 0.73	<0.0001	1.22	0.92, 1.61	0.17
60-119 months	0.81	0.63, 1.04	0.10	1.31	0.99, 1.74	0.06
120-414 months	0.65	0.47, 0.89	0.008	0.78	0.58, 1.05	0.11
Duration of service						
≤120 months	1.0[d]	--	--	1.0[d]	--	--
121-414 months	0.81	0.60, 1.08	0.14	0.67	0.53, 0.84	0.0006
Pay grade						
E1-E3	1.0[d]	--	--	1.0[d]	--	--
E4-E6	0.70	0.58, 0.84	<0.0001	1.01	0.89, 1.33	0.40
E7-E9	0.45	0.32, 0.62	<0.0001	0.44	0.33, 0.58	<0.0001
CMF[f]						
Support	1.0[d]	--	--	1.0[d]	--	--
Infantry	0.85	0.32, 2.26	0.74	2.01		<0.0001
E-M repair	1.93	1.34, 2.78	0.0004	1.33		0.24
Communication	1.54	1.16, 2.03	0.003	1.65	1.46, 2.78	0.01
Healthcare	1.25	0.96, 1.63	0.10	1.10	0.83, 2.13	0.72
Technical	1.89	1.15, 3.11	0.01	1.19	1.12, 2.45	0.64
Electrical	1.95	1.44, 2.64	<0.0001	1.64	0.65, 1.88	0.01
Craftsworkers	1.81	0.78, 4.23	0.17	1.66	0.57, 2.46	0.35
Service/supply	1.64	1.25, 2.15	0.004	1.14	1.13, 2.40	0.50
Non-occupational	0	0, 999	1.0	0	--	--
Kneeling						
None	1.0[d]	--	--	1.0[d]	--	--
Prolonged	0.75	0.61, 0.92	0.007	0.77	0.55, 1.07	0.12
While lifting, shoveling	1.03	0.73, 1.44	0.88	1.60	1.33, 1.93	<0.0001
While filing	1.16	0.62, 2.18	0.65	2.03	0.66, 6.25	0.22
Lifting						
None	1.0[d]	--	--	1.0[d]	--	--
Lift 1-25 lbs	0.76	0.59, 0.99	0.04	1.39	0.67, 2.88	0.38
Lift 26-50 lbs	0.77	0.55, 1.07	0.12	1.54	0.77, 3.08	0.22
Lift 51-75 lbs	0.96	0.71, 1.31	0.81	1.58	0.85, 2.92	0.15
Lift 76-100 lbs	1.04	0.81, 1.33	0.76	1.15	0.63, 2.09	0.66
Lift 101-125 lbs	1.37	0.94, 2.00	0.10	1.66	0.92, 3.01	0.09
Lift 126-150 lbs	0	0	0	1.05	0.50, 2.22	0.90
Lift 151-175 lbs	0.95	0.58, 1.57	0.85	2.22	1.24, 3.97	0.007
Raise 267 lbs	1.59	0.72, 3.49	0.25	1.23	0.51, 2.94	0.64
Sitting						
None	1.0[d]	--	--	1.0[d]	--	--
Any	0.71	0.57, 0.90	0.004	0.77	0.50, 1.18	0.23

	Women (N=2,772)			Men (N=2,574)		
	OR[b]	95% CI[b]	p[b]	OR[b]	95% CI[b]	p[b]
Standing						
None	1.0[d]	--	--	1.0[d]	--	--
Any	0.84	0.69, 1.03	0.09	0.63	0.50, 0.79	<0.0001
Push/pull						
None	1.0[d]	--	--	1.0[d]	--	--
< 130 lbs	1.03	0.78, 1.37	0.83	0.98	0.73, 1.33	0.90
≥ 130 lbs	1.05	0.72, 1.55	0.80	0.94	0.73, 1.21	0.63
Foot/pound force	1.26	0.73, 2.16	0.41	1.02	0.57, 1.83	0.94
Uses wrench	0	--	--	1.06	0.38, 2.98	0.92

a. Cases and controls with complete data for all terms included in final multivariable models.
b. OR=Odds ratio; 95% CI=95% confidence interval; p=p-value.
c. Quintiles based on distribution observed among all controls in data library.
d. Referent category.
e. Includes never married and no longer married.
f. CMF=Career Management Field: support=support/administration; infantry=infantry/gun crews; e-m repair=electrical/mechanical equipment repair; service=service/supply; communications=communications/intelligence; electrical=electrical equipment repair; technical=technical/allied specialties; non-occupational includes trainees, prisoners, and patients.

Among women, non-white race, being married, longer duration of service, and higher pay grade seemed to be associated with reduced risk of knee-related disability discharge. Certain CMF groups were associated with higher risk of disability discharge relative to the administration/support CMF. The CMF groups with the highest odds ratios were electrical/mechanical equipment repair, communications/intelligence, technical/allied specialties, electrical equipment repair, and service/supply. None of the specific job tasks we considered met our definition of practical or statistical significance.

In contrast to the results for the women, men aged 21-32 years (third and fourth quintiles) were at increased risk. As with the women, non-white men appeared to be at lower risk of disability discharge compared to white men, as were those with at least 120 months of service and a grade of at least E7. Relative to support/administration, the CMF groups with the highest ORs for men were infantry/gun crews, communications/ intelligence, and electrical equipment repair. Men in jobs associated with lifting more than 150 pounds or kneeling while shoveling were also at increased risk of knee-related disability discharge, while men in jobs associated with any amount of standing seemed to be at lower risk than men in jobs not associated with standing.

Multivariable Analyses

Women. In addition to quintiles of age and race (white/non-white), the final multivariable model for women included marital status (married yes/no), CMF groups, and pay grade. We also included duration of service, in quintiles, due to its influence on the magnitude of the coefficients of the other terms in the model (Table2.5).

Table 2.5. Probability of Discharge from the Army for Any Knee-Related Disability: N=2,772 Women (692 Cases)

	All women			White women			Non-white women		
	OR[a]	95% CI[a]	p[a]	OR[a]	95% CI[a]	p[a]	OR[a]	95% CI[a]	p[a]
Age[b]									
17-21 years	1.0[c]	--	--	1.0[c]	--	--	1.0[c]	--	--
21-22 years	0.79	0.57, 1.09	0.15	0.68	0.46, 1.01	0.05	1.09	0.61, 1.96	0.78
22-25 years	0.94	0.70, 1.27	0.69	0.86	0.60, 1.23	0.41	1.11	0.64, 1.93	0.71
26-32 years	1.59	1.21, 2.09	0.001	1.44	1.02, 2.04	0.04	1.96	1.23, 3.12	0.004
33-60 years	2.44	1.71, 3.47	<0.0001	2.66	1.66, 4.26	<0.0001	2.41	1.37, 4.26	<0.0001
Race									
White	1.0[c]	--	--	--	--	--	--	--	--
Nonwhite	0.50	0.41, 0.60	<0.0001	--	--	--	--	--	--
Married									
No[d]	1.0[c]	--	--	1.0[c]	--	--	1.0[c]	--	--
Yes	0.66	0.54, 0.81	<0.0001	0.63	0.49, 0.81	0.0003	0.71	0.51, 0.99	0.04
Duration of service[b]									
1-15 months	1.0[c]	--	--	1.0[c]	--	--	1.0[c]	--	--
16-32 months	1.07	0.78, 1.46	0.67	0.93	0.64, 1.36	0.71	1.52	0.88, 2.65	0.14
33-59 months	0.83	0.55, 1.25	0.36	0.87	0.53, 1.44	0.60	0.74	0.35, 1.56	0.43
60-119 months	1.30	0.85, 1.99	0.23	1.10	0.64, 1.91	0.71	1.72	0.83, 3.54	0.14
120-414 months	1.43	0.81, 2.55	0.22	1.23	0.56, 2.72	0.61	1.82	0.75, 4.44	0.19
CMF[e]									
Support	1.0[c]	--	--	1.0[c]	--	--	1.0[c]	--	--
Infantry	0.77	0.28, 2.08	0.60	0.66	0.18, 2.40	0.53	0.95	0.20, 4.53	0.95
E-M repair	1.62	1.11, 2.37	0.01	1.85	1.15, 2.96	0.01	1.19	0.60, 2.39	0.62
Communication	1.37	1.03, 1.83	0.03	1.37	0.95, 1.98	0.09	1.42	0.87, 2.33	0.16
Healthcare	1.10	0.84, 1.45	0.49	1.27	0.90, 1.79	0.18	0.79	0.46, 1.24	0.28
Technical	1.64	0.98, 2.75	0.06	1.46	0.78, 2.72	0.23	2.16	0.84, 5.60	0.11
Electrical	1.59	1.16, 2.19	0.004	1.42	0.95, 2.13	0.09	2.13	1.27, 3.58	0.004
Craftsworkers	1.55	0.65, 3.72	0.33	1.53	0.48, 4.92	0.47	1.50	0.40, 5.63	0.55
Non-occupational	0	--	--	0	--	--	0	--	--
Pay grade									
E1-E3	1.0[c]	--	--	1.0[c]	--	--	1.0[c]	--	--
E4-E6	0.62	0.45, 0.87	0.01	0.69	0.46, 1.03	0.07	0.49	0.28, 0.86	0.01
E7-E9	0.20	0.12, 0.35	<0.0001	0.25	0.12, 0.50	<0.0001	0.14	0.06, 0.33	<0.0001

a. OR=Odds ratio; 95% CI=95% confidence interval; p=p-value.
b. Quintiles based on distribution observed among all controls in data library.
c. Referent category.
d. Includes never married and no longer married.
e. CMF=Career Management Field: support=support/administration; infantry=infantry/gun crews; e-m repair=electrical/mechanical equipment repair; service=service/supply; communication=communications/intelligence; electrical=electrical equipment repair; technical=technical/allied specialties; non-occupational includes trainees, prisoners, and patients

Several terms that were only weakly associated with risk of knee-related disability discharge in single predictor models were more strongly associated with risk when other factors were controlled in the multivariable setting. Women in the highest two quintiles of age (26-32 years and 33-60 years) experienced an approximate doubling of risk relative to those in the youngest age group. Non-white women had a 50% decrease in risk of knee-related disability discharge relative to white women, and there was a 44% lower risk for married compared to unmarried women. Although none of the job tasks demonstrated an important effect on the risk of knee-related disability discharge, several of the CMF groups did show both statistically and practically important increases in risk relative to the administration/support CMF group. Three CMF groups demonstrated an approximate 60% increase in risk: technical/allied

specialties (OR=1.64; 95% CI, 0.98-2.75); electrical/mechanical equipment repair (OR=1.62; 95% CI, 1.11-2.37); and electrical equipment repair (OR=1.59; 95% CI, 1.16-2.19). Even after controlling for age, duration of service and CMF group, women in pay grades E4-6 had a 40% lower risk relative to women in grades E1-3, and women in grades E7-9 had an 80% lower risk relative to those in the lowest three pay grades. The Hosmer-Lemeshow goodness of fit statistic demonstrated an adequate fit of this model to the data (statistic=11.2, p=0.20 on 8 degrees of freedom).

We planned to evaluate effect modification by age, duration of service and pay grade; however, these factors were too highly correlated to be included in the same model. The Pearson correlation coefficient for age and duration of service (both as continuous variables) was 0.77, and 0.69 for age and duration of service (continuous scale). The Spearman correlation coefficient for quintiles of age and quintiles of duration of service was 0.67, and 0.62 for quintiles of age and pay grades E1-E9 (not shown).

As Table 2.5 shows, there is evidence of effect modification by race, particularly for risks associated with higher pay grades (where the decrease in risk for grades E4 and above relative to E1-E3 was greater for nonwhites than whites) and certain CMF groups (electrical/mechanical equipment repair; healthcare; technical/allied specialties; electrical equipment repair). For white women, the Hosmer-Lemeshow statistic indicated the model fits adequately, with the p=0.50. The model did not fit as well for non-white women; the value of the test statistic was 17.32, p=0.03 for 8 degrees of freedom.

Men. The final multivariable model for men contains age in quintiles, white vs. nonwhite race, duration of service 1-119 months or longer than 120 months, CMF groups, pay grade and categories of kneeling. Lifting and standing were important confounders of the terms included in the base model (based on > 20% change in coefficient), and so were also included in the final model (Table 2.6).

Table 2.6. Probability of Discharge from the Army for any Knee-Related Disability: N=2,574 Men (682 Cases)

	All men			White men			Non-white men		
	OR[a]	95% CI[a]	p[a]	OR[a]	95% CI[a]	p[a]	OR[a]	95% CI[a]	p[a]
Age[b]									
17-21 years	1.0[c]	--	--	1.0[c]	--	--	1.0[c]	--	--
21-22 years	1.96	1.42, 2.70	<0.0001	2.06	1.02, 4.15	0.04	1.99	1.38, 2.87	0.0002
22-25 years	2.72	1.95, 3.79	<0.0001	3.21	1.58, 6.51	<0.0001	2.66	1.82, 3.90	<0.0001
26-32 years	3.28	2.31, 4.66	<0.0001	4.74	2.32, 9.68	<0.0001	2.92	1.93, 4.41	<0.0001
33-60 years	4.72	2.99, 7.45	<0.0001	4.94	2.13, 11.5	<0.0001	5.31	3.01, 9.37	<0.0001
Race									
White	1.0[c]	--	--	--	--	--	--	--	--
Nonwhite	0.77	0.63, 0.93	0.008	--	--	--	--	--	--
Duration of service[b]									
1-119 months	1.0[c]	--	--	1.0[c]	--	--	1.0[c]	--	--
≥ 120 months	1.36	0.91, 2.05	0.14	1.47	0.77, 2.80	0.25	1.24	0.73, 2.10	0.43
CMF[d]									
Support	1.0[c]	--	--	1.0[c]	--	--	1.0[c]	--	--
Infantry	0.82	0.28, 2.42	0.71	1.55	0.17, 14	0.70	0.55	0.15, 2.01	0.37
E-M repair	0.63	0.17, 2.34	0.49	1.77	0.14, 23	0.66	0.42	0.09, 2.08	0.29
Communication	0.62	0.17, 2.27	0.47	3.14	0.24, 41	0.38	0.33	0.07, 1.58	0.17
Healthcare	0.53	0.16, 1.83	0.32	1.04	0.10, 11	0.97	0.38	0.08, 1.68	0.20
Technical	0.72	0.21, 2.48	0.60	1.09	0.10, 12	0.95	0.57	0.13, 2.54	0.46
Electrical	0.82	0.24, 2.53	0.73	1.31	0.13, 13	0.82	0.60	0.16, 2.31	0.46
Craftsworkers	1.31	0.26, 6.56	0.75	1.35	0.05, 36	0.86	1.18	0.17, 8.07	0.87
Service	0.54	0.18, 1.64	0.28	0.96	0.10, 9	0.97	0.37	0.10, 1.40	0.14
Non-occupational	0	--	--	0	--	--	0	--	--
Pay grade									
E1-E3	1.0[c]	--	--	1.0[c]	--	--	1.0[c]	--	--
E4-E6	0.72	0.57, 0.91	0.01	0.68	0.43, 1.06	0.09	0.70	0.53, 0.93	0.01
E7-E9	0.15	0.01, 0.23	<0.0001	0.13	0.06, 0.27	<0.0001	0.16	0.09, 0.27	<0.0001
Kneeling									
None	1.0[c]	--	--	1.0[c]	--	--	1.0[c]	--	--
Prolonged	0.67	0.20, 2.24	0.52	3.35	0.27, 42	0.35	0.43	0.10, 1.83	0.25
While lifting, shoveling	1.48	1.07, 2.04	0.02	1.41	0.80, 2.49	0.09	1.49	1.00, 2.22	0.05
While filing	2.95	0.67, 12.8	0.15	0	--	--	4.40	0.77, 25	0.12

	All men			White men			Non-white men		
	OR[a]	95% CI[a]	p[a]	OR[a]	95% CI[a]	p[a]	OR[a]	95% CI[a]	p[a]
Lifting									
None	1.0[c]	--	--	1.0[c]	--	--	1.0[c]	--	--
0-25 lbs	1.32	0.53, 3.28	0.55	0.50	0.10, 2.42	0.38	1.69	0.49, 5.82	0.41
26-50 lbs	1.35	0.69, 2.62	0.38	1.75	0.60, 5.05	0.30	1.28	0.53, 3.13	0.59
51-75 lbs	1.29	0.75, 2.32	0.40	0.56	0.18, 1.67	0.30	1.83	0.88, 3.84	0.11
76-100 lbs	1.14	0.61, 2.13	0.68	0.42	0.12, 1.53	0.19	1.57	0.73, 3.40	0.25
101-125 lbs	1.11	0.75, 1.72	0.64	1.05	0.50, 2.19	0.90	1.24	0.71, 2.17	0.46
126-150 lbs	0.58	0.30, 1.14	0.12	0.45	0.14, 1.50	0.19	0.69	0.30, 1.57	0.38
151-175 lbs	1.18	0.74, 1.90	0.47	1.02	0.47, 2.19	0.97	1.39	0.76, 2.54	0.29
Raises 267 lbs	0	--	--	0	--	--	0	--	--
Standing									
None	1.0[c]	--	--	1.0[c]	--	--	1.0[c]	--	--
Any	0.76	0.43, 1.35	0.35	0.60	0.20, 1.79	0.36	0.74	0.37, 1.47	0.39

a. OR=Odds ratio; 95% CI=95% confidence interval; p=p-value.
b. Quintiles based on distribution observed among all controls in data library.
c. Referent category.
d. CMF=Career Management Field: support=support/administration; infantry=infantry/gun crews; e-m repair=electrical/mechanical equipment repair; service=service/supply; communication=communications/intelligence; electrical=electrical equipment repair; technical=technical/allied specialties; non-occupational includes trainees, prisoners, and patients

Among the men in this study, the risk of knee-related disability discharge increased steadily with increasing quintiles of age. As we observed among the women, non-white men were at lower risk of disability discharge than whites. Even after controlling for age and all other terms in the model, men with at least 120 months (10 years) of service were at 36% higher risk of knee-related disability discharge compared to those with less than 10 years of service.

None of the 11 CMF groups demonstrated any important effect on the risk of discharge for disabling knee injury; most of the ORs associated with the CMF groups were between 0.5 and 0.8 compared to soldiers in support and administration. Only employment as a craftsworker was associated with an increase in risk relative to employment in the support/administration CMF (OR=1.31; 95% CI, 0.26-6.56). As we saw among the women, the risk of knee-related disability discharge was substantially lower for men with higher pay grades. Men in the E4-E6 pay grades were at 28% reduced risk, and men in the E7-E9 grades were at 85% reduced risk compared to men in grades E1-E3.

Although the CMF groups did not appear to be associated with risk of knee-related disability discharge, individuals in jobs with a requirement for kneeling, lifting and standing were at increased risk of discharge. Most categories of occupational lifting were associated with a 10%-30% higher risk compared to men whose job descriptions did not include lifting, although these estimates were not very precise. Male soldiers

whose job task descriptions included any standing were at nearly 30% lower risk of knee-related disability discharge compared to men whose job tasks did not include standing. Conversely, men in jobs associated with kneeling while shoveling (OR=1.5; 95% CI, 1.07-2.04) or filing (OR=2.95; 95% CI, 0.67-12.8) were at higher risk relative to men whose jobs were not associated with these tasks. The Hosmer-Lemeshow goodness of fit statistic for the final model for enlisted men had a value of 2.73, p=0.95 on 8 degrees of freedom, demonstrating adequate fit.

As we did for the women, we attempted to evaluate effect modification by age, duration of service and pay grade, and found these covariates too highly correlated to evaluate. The Pearson correlation coefficient for age and duration of service, (continuous scale) was 0.89. The Spearman correlation coefficients were 0.82 for quintiles of age and quintiles of duration of service, and 0.77 for quintiles of age and pay grades E1-E9 (not shown).

Race appeared to be an important effect modifier for the men, particularly for risks associated with duration of service (1.24 vs. 1.47, nonwhites and whites, respectively, with at least 120 months service relative to 1-119 months of service), and prolonged occupational kneeling (0.43 vs. 3.35). There were also differences in risk for nonwhites vs. whites in certain jobs. Nonwhites in the communications/intelligence CMF group were at 70% reduced risk compared to support/administration, while whites in this CMF were at 300% increased risk of discharge for knee-related disability relative to those in support/administration (Table 2.6). The model demonstrated adequate fit for both white and non-white men. The value of Hosmer-Lemshow statistic for white men was 5.07, with p=0.75 on 8 degrees of freedom. For nonwhites, the value of the test statistic was 6.0, with p=0.65 on 8 degrees of freedom.

DISCUSSION

While a number of researchers have previously noted sociodemographic differences in risk of occupational injury, these reports have primarily represented the results of descriptive analyses (2, 3, 6, 14, 15, 22, 23, 33, 37, 39, 52, 60, 62, 65). The results of the present study demonstrate important differences in risk of knee-related disability discharge from the U.S. Army according to occupational and demographic characteristics. The work reported here represents an extension of pilot research that considered sociodemographic and occupational characteristics separately (58, 64); we now present evidence that the sociodemographic differences in risk noted earlier operate independently of occupational exposures.

We observed that both male and female enlisted personnel with increasing pay grade were at reduced risk of knee-related disability discharge from the Army after controlling for age, race, duration of service and job characteristics. Few other characteristics of occupation appeared to have an impact on the risk of knee-related disability discharge. For men, longer duration of service and being in a job that required some amount of kneeling were associated with an increase in risk. Neither of these characteristics were important predictors of risk for women. The specific job held, as defined by CMF group, did not impact the risk of disability discharge for men, though it

was an important confounder of terms included in the final model. For women, most CMF groups had increased ORs compared to the "support/administration" CMF group. These estimates are generally quite imprecise, however.

Both CMF group and other job tasks are mapped from the PMOS. Other researchers have noted differences in risk of musculoskeletal disability generally, and knee-related disability in particular, that vary according to PMOS within the Army (23, 64). Those analyses, however, did not take into account duration of service and pay grade, two characteristics that may be more predictive of the type of work actually performed, and hence, the amount of physical risk incurred, than the job title.

Work exposures based on job title in this and in earlier research rely on ecological level exposure assessment. While PMOS is recorded for nearly every soldier, and expected job tasks are known for each job code, it is not known how many of the expected tasks are actually performed, or if the assigned and recorded PMOS accurately reflects the job being done by any individual soldier. As a result, there is likely to be a substantial amount of misclassification with respect to the work exposures we evaluated. In contrast, duration of service and pay grade are both individual level measures, which may explain why they were more important in multivariable models than were work exposures or CMF.

Race seems to exert a substantial modifying effect on the risks associated with work characteristics in these data. For both men and women, the relation between risk of disability discharge and CMF group was either greatly enhanced or reversed when whites and non-whites were evaluated separately. The differences between white and non-white men in the risks associated with certain job tasks are especially striking. These differences were evaluated in models that control for demographic characteristics other than race, and for other work characteristics (including pay grade and duration of service). Two possible explanations for the racial differences in risk of disability discharge are (1) that the expected work tasks actually performed by soldiers in certain CMF groups are distributed differently, and along racial lines, or (2) that there are important differences in the anatomical structure of the knee or leg of white and non-white individuals, leading to a different ability to heal following physical stresses.

An initial aim of this analysis was to subset the cases according to tissue type (soft tissue or bone) and the chronicity (acute or chronic) of the condition leading to the disability discharge. We expected that conditions that differed according to these characteristics might be associated with different sets of risk indicators. There were two available approaches for categorizing the conditions. First, we explored the specific VASRD codes assigned at the time of the disability determination (Table 2.1). These codes, developed for an entirely non-medical purpose, were insufficiently detailed with respect to the conditions they categorize to allow for the subsetting we required (49).

Second, we determined that about 60% of all cases recorded in the disability database can be linked with hospital records containing information used by the Physical Evaluation Boards in determining disability status. These records are stored in a separate data file and are designated as "card for record only" (CRO), since they contain information from the evaluative examination, but do not represent an inpatient admission. The CRO records do, however, contain up to eight diagnoses coded according to the International Classification of Diseases, 9th edition, Clinical Modification (ICD-9-CM). Our second approach, then, was to link the disability cases in this study with CRO records and to classify the associated ICD-9-CM diagnosis codes according to tissue type and chronicity. Although we were able to identify CRO records for some of the cases, we found that very few of the cases had both CRO and work exposure data available. In particular, as few as 32 of the women and 13 of the men would have been available for analyses stratified by tissue type or chronicity (Table 2.7), and so we were unable to develop stable models that considered both occupational and demographic risk factors for subsets of cases. Thus, in spite of the richness of the TAIHOD, its administrative nature precluded focused analyses of the correlates of knee-related disability discharge according to type of knee injury.

Table 2.7. Distribution of Cases According to Tissue Type and Chronicity of Diagnoses Noted in CRO[a] Records

	Women	Men
Tissue type		
Soft	237	107
Bony	105	38
Mixed	32	18
Total	**345**	**163**
Chronicity		
Acute	33	13
Chronic	107	45
Mixed	237	105
Total	**377**	**163**

[a] CRO=Card for Record Only: hospital records with physical examination data used for disability determinations.

It was surprising to discover problems related to missing data in the TAIHOD. We knew from pilot work and from preliminary analyses for this project that some of the component databases were more complete than others, and that some data elements were simply not available (58, 64). However, we selected variables for analysis with this knowledge in mind, and expected to lose a minimal number of observations to missing data. Unfortunately, upon cross-classifying individuals with respect to job and subtype of disability, the missing data problem was magnified to the point where we were unable to develop stable models.

There were other problems related to the administrative origins of the data included in TAIHOD. Specifically, we have no information on quality control procedures, nor means of verifying the consistency of coding practices across the many locations where data originated. It is also likely that there has been only limited quality control in

at least some of the data collection sites. In addition, as already described, we found that a number of the data fields, developed for a variety of purposes, include too many codes, or not enough variability in coding to be useful for analysis purposes.

Aside from these technical and data quality-related difficulties, there are certain weaknesses inherent in the design of this study. The primary problem is that "disability" in this setting refers to disability discharge from the Army, which is the culmination of a series of health-related and administrative events. The discharge itself may be remote in time from the initial injury. Any set of risk factors for disability discharge that we identify, therefore, will probably include risk factors for injury in addition to risk factors for disability discharge given that an injury occurred. The latter may include intrinsic factors related to healing and some presumably non-biological factors that influence the administrative procedures that lead to the determination of disability and the granting of financial benefits. These time-dependent issues will be addressed in additional analyses using the TAIHOD.

In spite of these problems, we found that the risk of knee-related disability discharge from the Army varies according to both demographic and work-related characteristics. This analysis represents one of the few analytic epidemiological studies of risk factors for occupational disability related to knee injury. Using the TAIHOD, we were able to evaluate both occupational and sociodemographic determinants of risk, and to explicitly investigate the separate risk factors that operate for men and women. We demonstrated, using knee-related disability, how administratively collected data may be used for research into risk factors for disabling injury. Analyses such as those conducted here may be used to identify specific high-risk work tasks or occupational groups that might be targeted for more detailed observation and intervention.

CHAPTER 3: RISK FACTORS FOR KNEE-RELATED HOSPITALIZATION AMONG U.S. ARMY ENLISTED PERSONNEL

INTRODUCTION

In previous work, we identified sociodemographic and occupational risk factors for disability discharge from the U.S. Army for knee-related conditions (49, 58, 64). Disability discharge from the Army represents the culmination of an administrative process, including a series of medical board hearings and physical examinations, which may take months both to initiate and to complete. As a consequence, the risk factors for disability discharge that we identified probably include a mixture of risk factors for the initial knee injury, for events leading to the initiation of the administrative process, and factors that influence the outcome of the process. To better understand the relation between the injury occurrence and the eventual disability determination, we undertook a case-control study of risk factors for knee injury among enlisted personnel in the U. S. Army. This study is based in the same population as the previous study. The two sets of results, taken together, should offer insights into the natural history of the occurrence of disabling knee injury among U.S. Army personnel.

Background

The Centers for Disease Control defines occupational injury as: "Any injury sustained during performance of 1) work for compensation, 2) volunteer work for an organized group, or 3) a work task on a farm" (3). The consequences of occupational injuries are manifold, and include physical, psychological and economic suffering for injured workers. In fact, occupational injuries result in more lost time from work, lost productivity, and lost working years of life than any other health condition in the United States(4, 31, 34). Employer costs also accrue, including the direct costs of temporary or permanent disability payments, and the indirect costs of lost productivity. Psychological consequences to the employer are related to declines in workplace morale among non-injured coworkers (21).

The Bureau of Labor Statistics (BLS) reported nearly 19 million nonfatal occupational injuries and illnesses involving lost workdays among employees of private industry during 1996 (2). During the same year, 3.3 million people aged 16 years or older were treated in emergency departments for occupational injuries, yielding a crude annual rate of 2.8/100 full-time equivalents (FTE) (3). The BLS data also demonstrate that occupational injury rates vary by categories of workers' age and sex. More than 70% of injuries treated in emergency departments were among workers aged 16-24 years, and the overall male:female ratio of rates of injuries treated was 1.6:1, with men treated for occupational injuries at a rate of 3.3/100 FTE, and women treated at a rate of 2.1/100 FTE. The highest male:female injury treatment rate ratios occurred among workers aged 18-24 years (2:1); the lowest male:female treatment rate ratio was among workers aged 75 years and older (0.7:1) (3).

Occupational Musculoskeletal Injuries

Among the most common types of occupational injuries are those to the musculoskeletal system (52). As a consequence, the CDC has identified musculoskeletal injuries as one of the top ten work-related health problems among civilian workers in the U.S.(1) Similarly, diseases of the musculoskeletal system represent the single most common reason for hospitalization in the Army, accounting for nearly 20% of all hospitalizations during 1992 (38, 55).

Knee problems represent a substantial proportion of musculoskeletal injuries among both civilian and military populations, and have been associated with physical demands placed on the knee. These demands may be the result of occupational activities such as sustaining static loads, lifting, and prolonged kneeling (33, 42, 43, 54, 59, 62). Leisure activities such as running and participation in certain sports have also been implicated in the development of knee injury and disability (24, 40, 42, 48, 61).

Research relating occupational exposures to musculoskeletal injury has commonly been descriptive in nature; the body of published analytical studies of work exposures and musculoskeletal injury is relatively small (32). The majority of these analyses fail to address differences in risk associated with sociodemographic characteristics, in spite of mounting evidence that such characteristics act as powerful effect modifiers. Gender and age are the most commonly addressed sociodemographic characteristics in the occupational injury literature, but these characteristics are generally considered potential confounders to be statistically controlled, not factors of intrinsic interest. For example, among recent civilian sector studies of occupational demands as risk factors for knee problems (15, 22, 39, 44, 54, 62, 65), one study included too few women with physically demanding occupations to conduct separate analyses (22), and two included sufficient numbers of women, but did not evaluate gender differences in risk (15, 62). When gender specific occupational injury rates are addressed, differences are typically found. Moreover, the differences tend to be dependent on age, work experience and job (39, 44, 65). These investigations highlight the importance of the potentially complex interrelations among sociodemographic and work factors in describing the risk of injury.

In the military setting, the vast majority of occupational injury research has included only men (37). Like research in the civilian sector, however, gender, when evaluated, has been found to be an important determinant of risk. Tomlinson et al. observed a reduced risk of both acute and over-use musculoskeletal injuries for women compared to men during an 18-month period (60). Enlisted women in the U.S. Navy have been shown to use medical services at higher rates than their male counterparts, and gender differences in hospitalization rates by injury type, job category and pay grade were also reported (29). Basic training classes have offered a convenient setting for studying injuries related to occupational physical activity in groups of young, healthy individuals, and several studies of recruits undergoing basic training have reported gender differences in the risk of musculoskeletal injury (27, 29, 36, 52). Descriptive analyses of U. S. Army data have shown that the rate of hospitalization specifically for knee injury has been increasing among active duty personnel through the mid-1980s

and 1990s, and that hospitalization rates for knee injuries differ by gender, race/ethnicity, and job (5, 55).

Unfortunately, the studies summarized above neither examined in detail nor adjusted for sociodemographic characteristics other than gender. In this report, we describe the results of a case-control study of sociodemographic and occupational risk factors for knee injury among active duty enlisted personnel in the U.S. Army. These analyses directly address the question of whether there exist independent occupational and sociodemographic risk factors for knee injury in a relatively young, healthy, working population.

MATERIALS AND METHODS

Data Sources

The Total Army Injury and Health Outcomes Database (TAIHOD) is a relational database that links demographic and occupational data on all Army personnel on active duty with databases tracking hospitalizations, lost work time injuries, and disability determinations. The structure and contents of the TAIHOD have been described in Chapter 2 of this report and elsewhere (7, 8).

Source Population and Data Library

The source population for this study consists of all enlisted personnel in the U.S. Army on active duty at any time between 1980 and 1997, about 244,000 women and 1.8 million men. We defined a data library with cases comprising all first-recorded knee-related disability discharges and an incidence-density sample of three controls per case, stratified by gender. We over-sampled women relative to men, using a control: case ratio of 6:1 for women and 1.5:1 for men. The data library included 9,634 cases and 19,877 controls. We constructed the data library with the intention of using it as a source for separately defined samples of cases and controls to address a series of research questions related to occupational knee injury and disability. Details regarding the construction of the data library are available elsewhere (7, 8). This report is based on the second such sampling from the data library.

Case Definition

Since no outpatient data were available in the TAIHOD, we used first hospitalization for knee-related problems to represent first reported knee injury. Although some milder injuries are undoubtedly excluded from study under this operational definition, we are assured of including all severe knee injuries. The diagnoses and procedures that we used to classify hospitalizations as knee-related are listed in Appendix B.

A total of 41,127 hospitalizations were recorded during the period January 1, 1980 through December 31, 1997 for individuals included in the data library. Of these, 10,443 (25%) were for knee-related problems based on the inclusion of at least one knee-related diagnosis or procedure in the hospitalization record. We identified the pool of potential cases as individuals whose first-recorded knee-related hospitalization occurred during the study period. There are 6,456 potential cases (701 women, 5755 men) available for inclusion in these analyses.

A preliminary review indicated that the TAIHOD may be less complete for its earliest years (not shown). We therefore restricted these analyses to cases recorded on or after January 1, 1984. For purposes relevant to a parallel analysis not discussed here, we truncated the eligibility period at December 31, 1994. A total of 500 women and 4,184 men experienced their first hospitalization for a knee problem during the study period. From this pool, we selected a subsample consisting of all 500 women and a self-weighted sample of 1,000 men. The weights represent the proportion of all male cases with a first knee-related hospitalization recorded in the data library for each calendar year between 1984 and 1994.

Control Definition

We used incidence density sampling to identify potential controls in proportion to the number of cases recorded in the data library for each calendar year from 1984 through 1994. Controls were drawn from the pool of enlisted personnel on active duty who had no recorded knee-related hospitalization as of that calendar year. Due to the relative lack of available work exposure data for controls (described below), we selected 6 controls per case. The sampling was stratified by sex, and yielded a pool of 9,000 potential controls (3,000 women and 6,000 men).

We obtained a separate work history file for all individuals included in the data library. The work history file generally contains job code and pay grade for every June and December during which a soldier was on active duty. Since a major goal of this project was to identify occupational exposures that influence the risk of knee-related hospitalization, all cases and controls included in these analyses were required to have work history data available for the appropriate exposure period (described below). Work history data were also used to restrict the sample to individuals on active duty and with enlisted pay grade during the exposure period. These restrictions resulted in N=1,364 cases (452 women, 912 men) and N=5,847 controls (1,975 women, 3,872 men) being available for analysis.

Occupational Exposures

Several preliminary steps were required to identify occupational exposures for these analyses. These steps included 1) determining the appropriate exposure information from the work history file; 2) revising obsolete job codes to follow a

consistent coding scheme over time; and 3) mapping job codes to occupational tasks and to CMF groups. Steps 2 and 3 have been described in Chapter 2.

For these analyses, the end of follow-up was defined as the year of the hospitalization for cases, and the year from which the controls were sampled. We evaluated the stability of job code over several intervals preceding the admission year. For all potential cases (N=6,456) and controls (N=21,925) included in the data library, we calculated the 6-month change rate for job codes recorded during the entire work history. The job change rate was calculated as the number of times the job code changed divided by the number of 6-month intervals for which any job code was recorded. For cases hospitalized on or after January 1, 1983, we also calculated the job change rate during 1, 2, and 4 years preceding the admission year.

Statistical Methods

We used SAS version 6.12 (SAS Institute, Cary, NC) for data management and all analyses. Once the relevant data for the members of the analytic subset were compiled from the various source files in TAIHOD, we evaluated univariate and bivariate frequency distributions to assess data quality and completeness, to assess the scale of continuous covariates, and to create categorical variables.

For the purpose of data reduction, we used single predictor logistic regression models to identify candidate terms to be included in multivariable regression models. In some cases, the single predictor models also enabled us to identify categories within multi-level covariates that could be collapsed due to the similarity of their point estimates. In order to include covariates that are both practically and statistically meaningful in identifying risk factors for knee-related hospitalization, we developed a decision rule that considered both the magnitude and precision of the effect. Any term with an odds ratio (OR) demonstrating at least a 50% change from the null value ($OR \leq 0.67$, $OR \geq 1.5$) that also was statistically significant ($p \leq 0.05$) in a single predictor model was considered a candidate for inclusion in the multivariable model. Terms that maintained this level of practical and statistical importance in the multivariable setting were retained in the final model.

We conducted all analyses separately for men and women, since we expected risk factors to operate differently for men and women based on our earlier findings regarding knee-related disability discharge from the Army (49, 58, 64). Also based on previous work (reported in Chapter 2 of this report), we evaluated effect modification by re-running the sex-specific final models separately for categories of age, race, and duration of service and comparing the resulting estimates across strata. Finally, we theorized that risk factors might operate differently depending on the type of injury being considered. To investigate this possibility, we conducted subgroup analyses based on the tissue type (soft tissue vs. bone) and chronicity of the condition (acute vs. chronic). We also examined risk factors for surgical and non-surgical knee-related hospitalizations.

Since our goal was to evaluate occupational risk factors for knee injury while taking into account demographic characteristics, we first identified the best multivariable model for the demographic variables in addition to age and race, then added individual work-related covariates. The "best" sociodemographic model was determined from the proportion of concordant and discordant observations based on the values predicted by the model; the amount of variability explained by the model (based on the magnitude of the p-values associated with each estimate); and the Hosmer-Lemeshow goodness of fit statistic (30). We used the same techniques to identify which of the work-related covariates should be considered as candidates for inclusion in a multivariable model that included both demographic and occupational information. Owing to substantial amounts of collinearity among terms considered in these analyses, we were unable to use standard methods (likelihood ratio tests, percent change in regression coefficients) for comparing models and assessing confounding.

RESULTS

Preliminary Analyses

Job Exposures. As shown in Table 3.1, the PMOS change rate for all cases is 0.037 jobs/6 months, similar to the rate of 0.036 jobs/6 months for the controls. The job change rate for cases evaluated in the 2- and 4-year intervals preceding the admission year are similar to the overall job change rate calculated for cases and controls (0.039 and 0.035 jobs/6 months, respectively). However, during the 12 months immediately preceding the admission year, the job change rate for cases dropped to 0.022 jobs/6 months. Since the job change rate for cases was markedly different for the year preceding the admission year, we used occupational exposures based on the job recorded in the 12 months preceding the admission year for both cases and controls. To reduce the amount of missing work history data, we used job information recorded according to the following hierarchy: 1) June of admission year; 2) December of admission year; 3) December of the year prior to the admission year; 4) June of the year prior to the admission year.

Table 3.1. Six-month Job Change Rate for all Potential Cases and Controls

	Overall	1 year[a]	2 years[a]	4 years[a]
Controls (N=21,925)	0.036	NA[b]	NA[b]	NA[b]
Cases (N=2,316)	0.037	0.039	0.035	0.022
Acute cases (N=427)		0.037	0.031	0.020
Chronic cases (N=340)		0.042	0.038	0.018
Mixed cases[c] (N=1,492)		0.040	0.035	0.024

a. Job change rate for 1, 2, and 4 years prior to first knee-related hospitalization for cases recorded on or after January 1, 1983.
b. NA=Not applicable.
c. Cases with diagnoses categorized as both acute and chronic. See Appendix B for details of categorization.

Before undertaking these analyses, we hypothesized that job changes experienced during the calendar year preceding the admission year would be most

relevant to the injury, either because the new job was inherently more dangerous, or because lack of familiarity with new work may increase the risk of injury. It could also be that a job change recorded in the period immediately preceding the hospitalization might reflect some level of work accommodation, if the hospitalization were for treatment of a worsening chronic condition, or the non-healing of an old injury that did not initially require hospitalization.

To explore these questions, we classified cases according the chronicity of the condition(s) leading to hospitalization (acute, chronic, or mixed) based on the diagnoses recorded in the hospital file (Appendix B) and recalculated the 6 month job change rate for each subgroup. If the change had been to more dangerous or to unfamiliar work, we would expect that the change rate would be highest among cases hospitalized for acute conditions. If the change represented a work accommodation, then we would expect that the job change rate in the period preceding hospitalization would be higher among the subgroup of cases with diagnoses indicating a chronic condition. We found that the job change rates for each type of case was similar to the job change rate noted for all cases within each interval preceding the admission year (Table 3.1).

Women

Bivariate Frequency Distributions. Table 3.2 shows the demographic and occupational characteristics of all cases and controls included in the analyses, stratified by sex. The cut points for the age and duration of service categories displayed in this table represent quintiles of those variables observed among all controls in the analytic subset (men and women combined).

Table 3.2. Demographic and Occupational Characteristics of Cases and Controls Included in the Analytic Subset[a]

	Women				Men			
	Cases (N=452)		Controls (N=1,975)		Cases (N=912)		Controls (N=3,872)	
	N	%	N	%	N	%	N	%
Age quintiles[b]								
18-22 years	96	21.24	392	19.85	256	28.07	800	26.67
23-25 years	98	21.68	444	22.48	241	26.43	807	20.85
26-29 years	109	24.12	497	25.16	205	22.48	838	21.65
30-33 years	67	14.82	338	17.11	115	12.61	592	15.29
34-59 years	82	18.14	304	15.39	95	10.42	834	21.54
Total	**452**		**1,975**		**912**		**3,871**	
Race								
White	261	57.74	896	45.46	610	67.03	2403	62.13
Black	170	37.61	919	46.63	242	26.58	1205	31.15
Other	21	4.65	156	7.91	58	6.37	260	6.72
Total	**452**		**2,106**		**910**		**3,868**	
Marital status								
Unknown	9	1.99	21	1.06	24	2.63	85	2.20
Single	224	49.56	793	40.19	400	43.86	1303	33.69
Married	190	42.04	972	49.27	465	50.99	2373	61.35
Divorced/ separated	29	6.42	187	9.48	23	2.52	107	2.77
Total	**452**		**1,973**		**912**		**3,868**	
Dependents								
None	0	0.00	1	0.05	0	0.00	4	0.10
One	246	54.42	987	50.03	411	45.07	1365	35.29
Two	103	22.79	517	26.20	163	17.87	647	16.73
Three	58	12.83	285	14.45	160	17.54	701	18.12
Four	32	7.08	135	6.84	126	13.82	727	18.80
Five or more	13	2.88	48	2.43	52	5.70	424	10.96
Total	**452**		**1,973**		**912**		**3,868**	
Education at entry[c]								
≤ High school	5	1.14	11	0.57	62	6.94	389	10.76
HS or GED[d]	364	82.73	1628	84.05	774	86.67	2952	81.64
≥ 1 year college	70	15.91	298	15.38	57	6.38	271	7.49
Alternate, unk[d]	1	0.23	0	0.00	0	0.00	4	0.00
Total	**440**		**1,937**		**893**		**3,616**	
Education at follow-up[c]								
≤ High school	3	0.67	13	0.66	22	2.41	130	3.37
HS or GED[d]	365	80.93	1611	81.69	835	91.56	3277	84.96
≥ 1 year college	83	18.40	348	17.65	55	6.03	448	11.62
Alternate, unk[d]	0	0.00	0	0.00	0	0.00	2	0.05
Total	**451**		**1,972**		912		3,857	
Pay grade group								
E1-E3	179	39.60	516	26.13	399	43.75	926	23.92
E4-E6	246	54.42	1356	68.66	478	52.41	2454	63.38
E7-E9	27	5.97	103	5.22	35	3.84	492	12.71
Total	**452**		**1,975**		**912**		**3,872**	
Duration of service[b]								
0-2 years	27	5.97	468	23.70	46	5.05	732	18.90
3-4 years	70	15.49	395	20.00	157	17.23	754	19.47
5-7 years	87	19.25	457	23.14	175	19.21	722	28.65
8-12 years	85	18.81	450	22.78	182	19.98	837	21.62
13-34 years	183	40.49	205	10.38	351	38.53	827	21.36
Total	**452**		**1,975**		**911**		**3,872**	

	Women				Men			
	Cases (N=452)		Controls (N=1,975)		Cases (N=912)		Controls (N=3,872)	
	N	%	N	%	N	%	N	%
CMF[e]								
Support	130	28.82	793	40.15	82	9.00	522	13.50
Infantry	4	0.89	20	1.01	367	40.29	1088	28.14
Electrical	24	5.32	85	4.30	58	6.37	323	8.35
Communication	66	14.63	243	12.30	87	9.55	418	10.81
Healthcare	86	19.07	349	17.67	46	5.05	253	6.54
Technical	19	4.21	54	2.73	19	2.09	103	2.66
E-M repair	46	10.20	161	8.15	150	16.47	608	15.73
Craftsworkers	2	0.44	16	0.81	23	2.52	80	2.07
Service	73	16.19	254	12.86	73	8.01	454	11.74
Non-occupational	1	0.22	0	0.00	6	0.66	17	0.44
Total	**451**		**1,975**		**911**		**3,866**	
Lifting/carrying								
None	22	6.59	86	5.64	14	2.24	114	4.54
1-25 lbs	73	21.86	461	30.25	20	3.21	110	4.38
26-50 lbs	38	11.38	226	14.83	26	4.17	154	6.14
51-75 lbs	53	15.87	197	12.93	60	9.62	249	9.92
76-100 lbs	99	29.64	406	26.64	119	19.07	585	23.31
101-125 lbs	30	8.98	66	4.33	118	18.91	499	19.88
126-150 lbs	0	0	0	0	20	3.21	82	3.27
151-175 lbs	13	3.89	56	3.37	234	37.50	666	26.53
Raises 267 lbs	6	1.80	26	1.71	13	2.08	51	2.03
Total	**334**		**1,524**		**624**		**2,510**	
Pushing/pulling								
None	258	77.25	1153	75.66	535	78.68	2007	75.74
< 130 lbs	48	14.37	228	14.96	51	7.50	251	9.47
≥ 130 lbs	23	6.89	98	6.43	73	10.74	333	12.57
Foot/pound force	5	1.50	45	2.95	14	2.06	46	1.74
Uses a wrench	0	0	0	0	7	1.03	13	0.49
Total	**334**		**1,524**		**680**		**2650**	
Run/walk								
None	30	12.93	142	12.14	60	9.98	227	12.14
1-25 feet	68	29.31	327	27.95	129	21.46	605	26.52
26-50 feet	41	17.67	129	11.03	142	23.63	508	22.27
51-100 feet	17	7.33	111	9.49	18	3.00	113	4.95
101-500 feet	4	1.72	54	4.62	26	4.33	120	5.26
0.25 mi-1 mile	72	31.03	407	34.79	226	37.60	658	28.85
Total	**232**		**1,170**		**601**		**2,281**	
Climbing								
None	272	88.60	1317	94.34	458	66.76	1879	72.10
3 feet	10	3.26	25	1.79	8	1.17	27	1.04
9 feet	5	1.63	10	0.72	46	6.71	179	6.75
10 feet	1	0.33	3	0.21	3	0.44	18	0.69
11 feet	8	2.61	24	1.72	8	1.17	39	1.50
30 feet	11	3.58	17	1.22	148	21.57	400	15.35
40 feet	0	0.00	0	0.00	6	0.87	30	1.15
50 feet	0	0.00	0	0.00	9	1.31	37	1.42
Total	**307**		**1,396**		**686**		**2,606**	
Kneeling								
None	197	59.34	758	50.33	342	51.20	1465	56.17
For prolonged periods	98	29.52	568	37.72	57	8.53	338	12.96
While shoveling, lifting	28	8.43	142	9.50	267	39.97	796	30.52
While filing	9	2.71	37	2.46	2	0.30	9	0.35
Total	**332**		**1,506**		**668**		**2,608**	

	Women				Men			
	Cases (N=452)		Controls (N=1,975)		Cases (N=912)		Controls (N=3,872)	
	N	%	N	%	N	%	N	%
Sitting								
None	76	22.75	485	31.82	25	3.68	148	5.58
Any	258	77.25	1039	68.18	655	96.32	2502	94.42
Total	**334**		**1,524**		**680**		**2,650**	
Standing								
None	169	50.60	838	54.99	107	15.74	679	25.62
Any	165	49.40	868	45.01	573	84.26	1671	74.38
Total	**334**		**1,524**		**746**		**2,060**	
Physical demands								
Very heavy	117	34.01	476	30.49	533	76.49	1946	67.97
Heavy	29	8.43	154	9.87	30	4.15	185	6.46
Moderately heavy	106	30.81	375	24.02	102	14.11	519	18.13
Medium	73	21.22	432	27.67	30	4.15	167	5.83
Light	19	5.22	124	7.94	8	1.11	46	1.61
Total	**344**		**1,561**		**723**		**2,863**	

a. Cases=knee-related hospitalization, 1984-1994. Controls=6:1 incidence density sample.
b. Quintiles based on frequency distribution observed for controls in the analytic subset.
c. Education at entry to service; education at end of follow-up (hospital admission year for cases).
d. HS=High school; GED=Graduate Equivalency Degree; unk=unknown.
e. CMF=Career Management Field: support=support/administration; infantry=infantry/gun crews; e-m repair=electrical/mechanical equipment repair; service=service/supply; communication=communications/intelligence; electrical=electrical equipment repair; technical=technical/allied specialties; non-occupational includes trainees, prisoners, and patients.

The distribution across quintiles of age is similar for female cases and controls, although cases are slightly under-represented in the fourth quintile, and slightly over-represented in the fifth quintile of age compared to controls. Female cases are also more likely to be of white race, single, and to have fewer dependents compared to controls. Cases and controls had similar levels of educational attainment, both at enlistment in the Army and at the end of the follow-up period for this study. While cases were more likely than controls to be in the lowest pay grade group (E1-E3), they tended to have longer duration of service.

The three most common CMFs for both female cases and controls were support/administration, healthcare and service/supply. In spite of the similarity in the distribution of cases and controls across CMF, there were some differences in the work tasks associated with their particular jobs. For example, female cases were more likely than controls to be in jobs associated with lifting greater amounts of weight (50-125 pounds). Cases were less likely to be in jobs associated with kneeling tasks, more likely to be in jobs associated with sitting and standing and to have jobs with moderately heavy physical demand ratings.

Single Predictor Models. Table 3.3 shows the results of single predictor models of the risk of knee-related hospitalization. Among women, there was about a 40% lower risk of hospitalization among nonwhites compared to whites, and a similar difference among the married and formerly married compared to single women. Compared to women with less than 2 years of service, the crude risk of knee-related hospitalization was three times higher for women with 2-12 years of service, and 16 times higher among women with more than 12 years of service. In contrast, increasing

pay grade was associated with a lower risk, especially for those in the middle category (E4-E6) compared to the lowest category (E1-E3).

Table 3.3. Single Predictor Logistic Regression models: Risk Factors for Knee-Related Hospitalization[a]

	Women (N=2,390)			Men (N=2,965)		
	OR[b]	95% CI[b]	p[b]	OR[b]	95% CI[b]	p[b]
Age[c]						
18-22 years	1.0[d]	--	--	1.0[d]	--	--
23-25 years	0.90	0.66, 1.23	0.43	0.99	0.78, 1.26	0.94
26-29 years	0.90	0.66, 1.21	0.50	0.77	0.62, 1.0	0.05
30-33 years	0.81	0.57, 1.14	0.23	0.72	0.54, 0.97	0.03
34-59 years	1.10	0.79, 1.53	0.57	0.40	0.29, 0.57	<0.0001
Race						
White	1.0[d]	--	--	1.0[d]	--	--
Nonwhite	0.61	0.49, 0.75	<0.0001	0.81	0.67, 0.97	0.03
Marital status						
Single	1.0[d]	--	--	1.0[d]	--	--
Married	0.69	0.56, 0.86	0.001	0.65	0.54, 0.78	<0.0001
Formerly married[e]	0.55	0.36, 0.83	0.01	1.11	0.65, 1.91	0.70
Dependents						
One	1.25	0.97, 1.61	0.08	1.28	0.99, 1.65	0.06
Two	1.0	--	--	1.0[d]	--	--
Three	1.36	0.71, 2.60	0.35	0.53	0.35, 0.81	0.003
Four	0.75	0.38, 1.48	0.41	1.79	1.17, 2.73	0.007
Five or more	0.88	0.42, 1.81	0.72	1.59	1.03, 2.46	0.04
Education at entry						
≤ 4 years HS	2.03	0.70, 5.89	0.19	0.65	0.47, 0.91	0.01
HS or GED	1.0[d]	--	--	1.0[d]	--	--
≥ 1 yr college	1.05	0.79, 1.39	0.73	0.78	0.53, 1.14	0.20
Education at follow-up						
≤ 4 years HS	1.02	0.29, 3.59	0.98	0.60	0.34, 1.07	0.08
HS or GED	1.0[d]	--	--	1.0[d]	--	--
≥ 1 yr college	1.05	0.81, 1.37	0.70	0.55	0.37, 0.81	0.002
Duration of service[c]						
0-2 years	1.0[d]	--	--	1.0[d]	--	--
3-4 years	3.07	1.93, 4.88	<0.0001	3.32	2.21, 5.00	<0.0001
5-7 years	3.30	2.10, 5.18	<0.0001	4.14	2.76, 6.21	<0.0001
8-12 years	3.27	2.08, 5.15	<0.0001	4.08	2.74, 6.09	<0.0001
13-34 years	16	10, 24	<0.0001	9.34	6.33, 14	<0.0001
Pay grade						
E1-E3	1.0[d]	--	--	1.0[d]	--	--
E4-E6	0.52	0.42, 0.65	<0.0001	0.49	0.41, 0.59	<0.0001
E7-E9	0.76	0.48, 1.19	0.23	0.17	0.10, 0.30	<0.0001
CMF[f]						
Support	1.0[d]	--	--	1.0[d]	--	--
Infantry	1.22	0.41, 3.63	0.72	2.03	1.49, 2.78	<0.0001
Electrical	1.72	1.06, 2.81	0.03	1.57	0.97, 2.52	0.07
Communication	1.66	1.19, 2.30	0.003	1.70	1.14, 2.53	0.01
Healthcare	1.50	1.11, 2.03	0.008	1.03	0.62, 1.72	0.90
Technical	2.15	1.23, 3.74	0.007	1.66	0.84, 3.27	0.14
E-M repair	1.74	1.20, 2.54	0.004	1.34	0.92, 1.94	0.13
Craftsworkers	0.76	0.17, 3.36	0.72	3.09	1.18, 8.08	0.02
Service	1.75	1.27, 2.41	0.001	0.94	0.64, 1.39	0.76

	Women (N=2,390)			Men (N=2,965)		
	OR[b]	95% CI[b]	p[b]	OR[b]	95% CI[b]	p[b]
Lifting						
None	1.0[d]	--	--	1.0[d]	--	--
1-50 lbs	0.63	0.38, 1.05	0.08	1.45	0.73, 2.86	0.29
51-100 lbs	0.99	0.60, 1.63	0.95	1.68	0.90, 3.14	0.10
101-150 lbs	1.78	0.94, 3.36	0.08	1.84	0.98, 3.45	0.06
151-175 lbs	0.91	0.42, 1.95	0.80	2.81	1.51, 5.23	0.001
Raise 267 lbs	0.90	0.33, 2.46	0.84	2.19	0.93, 5.19	0.07
Pushing/pulling						
None	1.0[d]	--	--	1.0[d]	--	--
< 130 lbs	0.94	0.67, 1.32	0.73	0.81	0.59, 1.11	0.20
≥ 130 lbs	1.05	0.65, 1.68	0.84	0.85	0.64, 1.11	0.23
Foot/pound force	0.50	0.20, 1.26	0.14	1.21	0.66, 2.23	0.54
Uses wrench	0	--	--	2.01	0.80, 5.05	0.14
Running/walking						
None	1.0[d]	--	--	1.0[d]	--	--
1-25 feet	0.98	0.61, 1.58	0.95	0.94	0.66, 1.35	0.74
26-50 feet	1.50	0.89, 2.55	0.13	1.02	0.70, 1.51	0.91
51-100 feet	0.73	0.38, 1.38	0.33	0.61	0.32, 1.18	0.14
101-500 feet	0.35	0.12, 1.04	0.06	0.95	0.55, 1.63	0.85
0.25-1 mile	0.84	0.53, 1.34	0.46	1.61	1.15, 2.25	0.006
3 miles	0	--	--	0	--	--
25 miles	0	--	--	0	--	--
Climbing						
None	1.0[d]	--	--	1.0[d]	--	--
3 feet	1.94	0.92, 4.08	0.08	1.25	0.56, 2.79	0.58
9 feet	0	--	--	1.10	0.78, 1.55	0.59
10 feet	2.42	0.82, 7.14	0.11	0.76	0.22, 2.63	0.67
11 feet	1.61	0.17, 16	0.68	0.86	0.29, 2.53	0.78
30 feet	0	--	--	1.60	1.28, 2.00	<0.0001
40 feet	0	--	--	0	--	--
50 feet	0	--	--	1.02	0.49, 2.13	0.97
Kneeling						
None	1.0[d]	--	--	1.0[d]	--	--
Prolonged	0.66	0.51, 0.87	0.003	0.78	0.57, 1.07	0.12
While lifting, shoveling	0.75	0.49, 1.16	0.20	1.59	1.31, 1.92	<0.0001
While filing	0.94	0.44, 1.97	0.86	0.99	0.21, 4.60	0.99
Sitting						
None	1.0[d]	--	--	1.0[d]	--	--
Any	0.63	0.48, 0.83	0.001	0.73	0.46, 1.16	0.19
Standing						
None	1.0[d]	--	--	1.0[d]	--	--
Any	0.84	0.66, 1.06	0.15	0.56	0.45, 0.71	<0.0001
Physical demand rating						
Very heavy	1.0[d]	--	--	1.0[d]	--	--
Heavy	0.77	0.49, 1.20	0.24	0.60	0.38, 0.93	0.02
Moderately heavy	1.15	0.86, 1.55	0.35	0.70	0.54, 0.90	0.005
Medium	0.69	0.50, 0.95	0.02	0.69	0.42, 1.14	0.14
Light	0.62	0.37, 1.05	0.08	0.65	0.19, 2.43	0.50

a. Cases and controls with complete data for all terms included in final multivariable models.
b. OR=Odds ratio; 95% CI=95% confidence interval; p=p-value.
c. Quintiles based on distribution observed among all controls in the analysis set.
d. Referent category.
e. Includes widowed, divorced, and separated.
f. CMF=Career Management Field: support=support/administration; infantry=infantry/gun crews;
e-m repair=electrical/mechanical equipment repair; service=service/supply; communication=communications/intelligence; electrical=electrical equipment repair; technical=technical/allied specialties; non-occupational includes trainees, prisoners, and patients

When compared with the support/administration CMF, the majority of CMF were associated with higher risks of knee-related hospitalization. The highest odds ratios (OR) were for the technical/allied specialties (OR=2.15; 95% CI, 1.23-3.74) and service/supply (OR=1.75; 95% CI, 1.27-2.41). Although there were differences in risk associated with the various CMF, the only job tasks that demonstrated important changes from the null value in single predictor models were kneeling (OR=0.66; 95% CI, 0.51-0.87 for prolonged kneeling vs. none) and sitting (OR=0.63; 95% CI, 0.48-0.83 for any sitting vs. none). Women whose jobs were rated as having medium physical demands were also at about 30% (OR=0.69; 95% CI, 0.50-0.95) lower risk of knee-related hospitalization compared to women in very heavy demand jobs.

Multivariable Modeling. Based on previous research showing that the risk of knee-related disability discharge from the Army depends on age and race, we began all multivariable models with these terms included. The final multivariable model for women consisted of quintiles of age, race (white/nonwhite), marital status (married and formerly married vs. single), pay grade group (E3-E6, E7-E9, vs. E1-E3) and CMF (each compared to support/administration).

Controlling for these demographic and occupational factors greatly strengthened several of the relations we observed in the single predictor models (Table 3.4a). In particular, increasing quintiles of age were associated with higher risks of knee-related hospitalization that ranged from 40% for 23-25 year olds (OR=1.41; 95% CI, 1.00-1.99) to almost 160% for women in the oldest age group, 34-59 years (OR=2.59; 95% CI, 1.64-4.09). Nonwhite women showed a more than 30% decline in risk of knee-related hospitalization compared to white women (OR=0.68; 95% CI, 0.55-0.85), and women who were married or formerly married at the end of follow-up also demonstrated declines in risk relative to single women (30% and 47% declines in risk, respectively). Pay grades above the E3 level conferred about a 50% reduction in risk of hospitalization.

Table 3.4a. Multivariable Logistic Regression Models: Risk Factors for Knee-Related Hospitalization among Women, Stratified by Race

	All women[a]			White women[a]			Nonwhite women[a]		
	OR[b]	95% CI[b]	p[b]	OR[b]	95% CI[b]	p[b]	OR[b]	95% CI[b]	p[b]
Age[c]									
18-22 years	1.0[d]	--	--	1.0[d]	--	--	1.0[d]	--	--
23-25 years	1.41	1.00, 1.99	0.05	1.11	0.72, 1.70	0.65	2.30	0.26, 4.20	0.007
26-29 years	1.82	1.26, 2.63	0.001	1.59	0.99, 2.57	0.06	2.73	1.46, 5.10	0.002
30-33 years	1.77	1.16, 2.69	0.008	1.33	0.76, 2.33	0.31	3.01	1.52, 5.98	0.002
34-59 years	2.59	1.64, 4.09	<0.0001	2.22	1.21, 3.90	0.009	4.18	1.98, 8.83	0.002
Race									
White	1.0[d]	--	--	--	--	--	--	--	--
Nonwhite	0.68	0.55, 0.85	0.0006	--	--	--	--	--	--
Marital status									
Single	1.0[d]	--	--	1.0[d]	--	--	1.0[d]	--	--
Married	0.71	0.56, 0.91	0.006	0.66	0.47, 0.90	0.01	0.78	0.54, 1.12	0.17
Formerly married[e]	0.53	0.33, 0.83	0.005	0.68	0.37, 1.25	0.01	0.39	0.19, 0.78	0.008
Pay grade									
E1-E3	1.0[d]	--	--	1.0[d]	--	--	1.0[d]	--	--
E4-E6	0.47	0.36, 0.63	<0.0001	0.46	0.32, 0.66	<0.0001	0.46	0.29, 0.71	0.0006
E7-E9	0.53	0.29, 0.94	0.03	0.27	0.12, 0.63	0.002	1.04	0.45, 2.40	0.94
CMF[f]									
Infantry	1.00	0.33, 3.02	0.99	0.56	0.12, 2.60	0.46	2.53	0.46, 14	0.29
Electrical	1.44	0.86, 2.39	0.16	1.30	0.64, 2.61	0.47	1.58	0.75, 3.30	0.23
Communication	1.50	1.07, 2.11	0.02	1.52	0.95, 2.43	0.08	1.49	0.90, 2.47	0.12
Healthcare	1.32	0.96, 1.80	0.08	1.60	1.05, 2.44	0.03	0.93	0.57, 1.50	0.79
Technical	1.94	1.10, 3.42	0.02	2.38	1.19, 4.75	0.01	1.40	0.46, 4.20	0.55
Support	1.0[d]	--	--	1.0[d]	--	--	1.0[d]	--	--
E-M repair	1.35	0.91, 2.00	0.14	1.03	0.59, 1.78	0.93	2.06	1.17, 3.64	0.01
Craftsworkers	0.64	0.14, 2.87	0.56	0.55	0.07, 4.53	0.57	0.72	0.09, 6.00	0.76
Service	1.53	1.10, 2.13	0.01	1.73	1.09, 2.75	0.02	1.21	0.73, 1.99	0.46

a. All women: N=2,772 (692 cases); White women: N=1,504 (464 cases); Non-white women: N=1,268 (228 cases).
b. OR=Odds ratio; 95% CI=95% confidence interval; p=p-value.
c. Quintiles based on distribution observed among all controls in the analysis set.
d. Referent category.
e. Includes widowed, divorced, and separated.
f. CMF=Career Management Field: support=support/administration; infantry=infantry/gun crews; e-m repair=electrical/mechanical equipment repair; service=service/supply; communication=communications/intelligence; electrical=electrical equipment repair; technical=technical/allied specialties; non-occupational includes trainees, prisoners, and patients

In contrast to the rather strong negative association with race, marital status, and pay grade, most of the CMFs tended to confer a weak increase in risk of knee-related hospitalization relative to jobs categorized in the support/administration CMF. The highest ORs were for women in technical/allied specialties (OR=1.94; 95% CI, 1.10-3.42), service/supply (OR=1.53; 95% CI, 1.10-2.13), and communications/intelligence (OR=1.50; 95% CI, 1.07-2.11).

Evaluation of Effect Modification.

Race. Although the patterns of increasing and decreasing risk associated with each of the demographic and occupational characteristics included in the multivariable model were similar for whites and nonwhites, many of the associations noted above were stronger and more precise in analyses restricted to nonwhite women (Table 3.4a). In addition, there were a few instances where the direction of the effect was reversed for white and nonwhite women. The decline in risk noted for women in the highest pay

grade group, for example, was restricted to white women (OR=0.27; 95% CI, 0.12-0.63); for nonwhite women with pay grade E6-E9, there was no difference in risk compared to being in the lowest pay grade group (OR=1.04; 95% CI, 0.45-2.40). White women in the infantry/gun crews CMF seemed to have a lower risk of knee-related hospitalization compared to those in the support/administration CMF (OR=0.56; 95% CI, 0.12-2.60), while nonwhite women in these jobs seemed to have a higher risk (OR=2.56; 95% CI, 0.46-14). Similarly, being in the healthcare CMF was associated with a 60% higher risk of knee-related hospitalization for white women (OR=1.60; 95% CI, 1.05-2.44), but not for nonwhite women in these jobs (OR=0.93; 95% CI, 0.57-1.50). There is a great deal of imprecision associated with these point estimates.

Duration of Service. Duration of service, age and pay grade categories were strongly interrelated, with Spearman correlation coefficients of r_{SP} (age, duration of service)=0.70; r_{SP} (age, pay grade)=0.59; and r_{SP} (duration of service, pay grade)=0.71. To evaluate effect modification by duration of service, therefore, it was necessary to remove pay grade and age from the final model we developed for the women. Similarly, the most stable model stratified by age group resulted when we excluded pay grade as a covariate.

Duration of service acts as a modifier of the effects estimated for the sociodemographic variables remaining in the model (Table 3.4b). Among women with up to four years of service in the Army, the risk of knee-related hospitalization was about 40% lower in nonwhites compared to whites (OR=0.56; 95% CI, 0.35-0.90). Nonwhite women with 5 to12 years of service were at nearly 70% lower risk than white women in this category (OR=0.32; 95% CI, 0.22-0.47), while nonwhite women with 13-34 years of service were at a 24% higher risk relative to whites (OR=1.24; 95% CI, 0.81-1.92). In contrast, the lower risk associated with being married or formerly married was consistent across categories of duration of service, and the point estimates varied only slightly in their magnitude and precision.

Table 3.4b. Multivariable Logistic Regression Models: Risk Factors for Knee-Related Hospitalization among Women, Stratified by Duration of Service

	1-4 years[a]			5-12 years[a]			13-34 years[a]		
	OR[b]	95% CI[b]	p[b]	OR[b]	95% CI[b]	p[b]	OR[b]	95% CI[b]	p[b]
Race									
White	1.0[c]	--	--	1.0[c]	--	--	1.0[c]	--	--
Nonwhite	0.56	0.35, 0.90	0.02	0.32	0.22, 0.47	<0.0001	1.24	0.81, 1.92	0.33
Marital status									
Single	1.0[c]	--	--	1.0[c]	--	--	1.0[c]	--	--
Married	0.41	0.24, 0.71	0.001	0.28	0.19, 0.40	<0.0001	0.51	0.29, 0.89	0.02
Formerly married[d]	0.45	0.10, 1.95	0.29	0.10	0.04, 0.29	<0.0001	0.20	0.10, 0.40	<0.0001
CMF[e]									
Infantry	0.00	0, 999	0.99	1.08	0.21, 5.58	0.92	999	0, 999	0.99
Electrical	2.22	0.82, 6.01	0.12	2.46	1.04, 5.78	0.04	1.32	0.47, 3.69	0.60
Communication	2.22	1.07, 4.61	0.03	1.74	1.02, 3.00	0.04	1.26	0.61, 2.60	0.53
Healthcare	1.57	0.76, 3.24	0.22	1.32	0.77, 2.26	0.31	1.31	0.74, 2.32	0.35
Technical	0	0, 999	0.99	1.79	0.71, 4.55	0.22	2.06	0.76, 5.61	0.16
Support	1.0[c]	--	--	1.0[c]	--	--	1.0[c]	--	--
E-M repair	2.37	1.12, 5.01	0.02	2.54	1.35, 4.76	0.004	1.70	0.65, 4.49	0.28
Craftsworkers	0	0, 999	0.99	0.72	0.08, 6.38	0.77	999	0, 999	0.99
Service	3.10	1.61, 5.95	0.001	1.75	0.98, 3.12	0.06	1.93	0.94, 3.98	0.07

a. Quintiles 1 and 2=1-4 years: N= 1,274 (358 cases); quintiles 3 and 4=5-12 years: N= 1,196 (269 cases); quintile 5=13-39 years: N=302 (65 cases).
b. OR=Odds ratio; 95% CI=95% confidence interval; p=p-value.
c. Referent category.
d. Includes widowed, divorced, and separated.
e. CMF=Career Management Field: support=support/administration; infantry=infantry/gun crews; e-m repair=electrical/mechanical equipment repair; service=service/supply; communication=communications/intelligence; electrical=electrical equipment repair; technical=technical/allied specialties.

We were not able to estimate coefficients for all of the CMF groups, due to empty cells in the stratified analysis. Among those CMFs with sufficient data for this analysis, there were moderate differences in both the strength and precision of the estimated ORs across strata of duration of service, but all of the effects are in the same direction. The most striking difference across strata was for the service/supply CMF, which was associated with a tripling of risk compared to support/administration among women with up to 4 years of service, (OR=3.1; 95% CI, 1.61-5.95), but only a 75% higher risk among women with 5-12 years of service (OR=1.75; 95% CI, 0.98-3.12) and a 93% higher risk among women with 13 or more years of service (OR=1.93; 95% CI, 0.94-3.98).

Age. In spite of the strong interrelation between duration of service and pay grade, the patterns of effects across categories of age were rather different than the patterns of effects across pay grade groups (Table 3.4c). For the sociodemographic characteristics of race and marital status, the effects seemed to be strongest among the youngest women, and essentially nonexistent among the women in the oldest age group. The effects we observed for CMF also tended to be strongest among women in the two youngest age groups, but the pattern was not entirely consistent. Some of the inconsistency arises from the small number of observations among certain CMFs. In particular, the effect of having a job classified as infantry/gun crews was inestimable except for women aged 26-33 years; similarly, craftsworkers were only represented

among women in the oldest age category. Both the strength and precision of the estimates were reduced with increasing age for CMF (except for service/supply) that were represented in all three of the age categories. For the service/supply CMF, women in the in the youngest (OR=2.33; 95% CI, 1.44-3.79) and oldest (OR=1.63; 95% CI, 0.75-3.54) age groups were at higher risk of knee-related hospitalization relative to women in the support/administration CMF. There was no difference from the referent category for women aged 26-33 years whose jobs were in the service/supply CMF (OR=0.96; 95% CI, 0.53-1.76).

Table 3.4c. Multivariable Logistic Regression Models: Risk Factors for Knee-Related Hospitalization among Women, Stratified by Age

	18-25 years[a]			26-33 years[a]			34-59 years[a]		
	OR[b]	95% CI[b]	p[b]	OR[b]	95% CI[b]	p[b]	OR[b]	95% CI[b]	p[b]
Age[c]									
18-22 years	--	--	--	--	--	--	--	--	--
23-25 years	--	--	--	--	--	--	--	--	--
26-29 years	--	--	--	--	--	--	--	--	--
30-33 years	--	--	--	--	--	--	--	--	--
34-59 years	--	--	--	--	--	--	--	--	--
Race									
White	1.0[d]	--	--	--	--	--	--	--	--
Nonwhite	0.57	0.41, 0.80	0.001	0.68	0.48, 0.96	0.03	0.90	0.54, 1.51	0.70
Marital status									
Single	1.0[d]	--	--	1.0[d]	--	--	1.0[d]	--	--
Married	0.54	0.38, 0.78	0.001	0.72	0.50, 1.02	0.07	0.95	0.47, 1.92	0.89
Formerly married[e]	0.14	0.02, 1.09	0.06	0.64	0.34, 1.19	0.16	0.63	0.26, 1.49	0.29
CMF[f]									
Infantry	0.00	0, 999	0.99	1.45	0.38, 5.60	0.59	999	0, 999	0.99
Electrical	2.35	1.12, 4.96	0.02	1.53	0.66, 3.53	0.32	0.64	0.18, 2.30	0.50
Communication	2.45	1.47, 4.08	0.0006	1.00	0.57, 1.75	0.99	1.11	0.48, 2.57	0.81
Healthcare	1.95	1.17, 3.27	0.01	1.04	0.65, 1.65	0.88	1.28	0.62, 2.62	0.51
Technical	2.22	0.82, 5.98	0.11	1.97	0.86, 4.53	0.11	1.59	0.47, 5.43	0.46
Support	1.0[d]	--	--	1.0[d]	--	--	1.0[d]	--	--
E-M repair	1.98	1.10, 3.57	0.02	1.55	0.87, 2.76	0.14	0.87	0.23, 3.24	0.84
Craftsworkers	0	0, 999	0.99	0	0, 999	0.99	4.44	0.59, 33	0.15
Service	2.33	1.44, 3.79	0.0006	0.96	0.53, 1.76	0.90	1.63	0.75, 3.54	0.21

a. Quintiles 1 and 2=18-25 years: N=967 (236 cases); quintiles 3and 4=26-33 years: N=1,370 (333 cases); quintile 5=34-59 years: N=435 (123 cases).
b. OR=Odds ratio; 95% CI=95% confidence interval; p=p-value.
c. Quintiles based on distribution observed among all controls in the analysis set.
d. Referent category.
e. Includes widowed, divorced, and separated.
f. CMF=Career Management Field: support=support/administration; infantry=infantry/gun crews; e-m repair=electrical/mechanical equipment repair; service=service/supply; communication=communications/intelligence; electrical=electrical equipment repair; technical=technical/allied specialties; non-occupational includes trainees, prisoners, and patients.

Subgroup Analyses. Forty-seven cases of knee-related hospitalization could be categorized as "acute" based on their diagnoses and procedures, and 83 cases could be categorized as "chronic". Similarly, 281 cases involved damage to soft tissue, only, while 122 cases involved bone, only. We considered the remaining cases to be of mixed chronicity or tissue type, respectively, primarily due to the presence of multiple diagnosis and procedure codes on a single record (Appendix B). Table 3.4d shows the

results of multivariable modeling for the subgroup of cases defined by chronicity, and Table 3.4e shows the results based on tissue type.

Chronicity. In contrast to the effects we observed for the risk of hospitalization for any knee problem, we observed a lower risk of hospitalization for acute knee problems with increasing quintiles of age through the fourth quintile. There was essentially no difference in risk of hospitalization for acute knee problems among the 34-59 year old women compared to 18-22 year old women (OR=0.97; 95% CI, 0.27-3.44). As we observed for all types of knee problems, the risk of hospitalization for acute knee trouble was lower among nonwhite relative to white women, although the effect was somewhat attenuated in the subgroup analysis (OR=0.76; 95% CI, 0.42-1.39). Similarly, the lower risk of knee-related hospitalization among married and formerly married women relative to single women and among those in higher pay grades relative to those in the lower pay grades persisted when we restricted cases to those hospitalized for acute knee problems (Table 3.4d).

The patterns of higher risk associated with the various CMF relative to the support/administration CMF were similar to those we observed among all cases of knee-related hospitalization, although there were differences in the magnitude of the point estimates. The only notable difference was among women in the service/supply CMF, who demonstrated a 70% reduction in risk of hospitalization for acute knee problems relative to women in the support/administration CMF. Not surprisingly, with only 47 cases in this sub-analysis, there was a substantial lack of precision in all point estimates (Table 3-4d).

Table 3.4d. Multivariable Logistic Regression Models: Risk Factors for Knee-Related Hospitalization among Women, Stratified by Chronicity

	Acute Cases			Chronic Cases		
	OR[b]	95% CI[b]	p[b]	OR[b]	95% CI[b]	p[b]
Age[c]						
18-22 years	1.0[c]	--	--	1.0[c]	--	--
23-25 years	0.82	0.35, 1.92	0.65	2.05	0.89, 4.75	0.09
26-29 years	0.81	0.31, 2.07	0.64	2.77	1.16, 6.61	0.02
30-33 years	0.51	0.15, 1.77	0.29	3.35	1.32, 8.50	0.01
34-59 years	0.97	0.27, 3.44	0.96	3.81	1.39, 10	0.01
Race						
White	1.0[d]	--	--	--	--	--
Nonwhite	0.76	0.42, 1.39	0.38	0.45	0.28, 0.72	0.001
Marital status						
Single	1.0[d]	--	--	1.0[d]	--	--
Married	0.52	0.26, 1.04	0.07	0.75	0.46, 1.24	0.27
Formerly married[e]	0.61	0.17, 2.21	0.45	0.48	0.19, 1.22	0.12
Pay grade						
E1-E3	1.0[d]	--	--	1.0[d]	--	--
E4-E6	0.63	0.30, 1.36	0.24	0.68	0.37, 1.25	0.22
E7-E9	0.60	0.10, 3.72	0.58	1.14	0.40, 3.30	0.81
CMF[f]						
Infantry	0.00	0, 999	0.99	1.13	0.14, 8.88	0.91
Electrical	1.01	0.22, 4.54	0.99	1.16	0.39, 3.45	0.79
Communication	1.74	0.75, 4.04	0.20	1.19	0.59, 2.40	0.62
Healthcare	1.42	0.63, 3.19	0.40	1.05	0.56, 1.99	0.87
Technical	1.95	0.43, 8.89	0.39	0.77	0.18, 3.36	0.73
Support	1.0[d]	--	--	1.0[d]	--	--
E-M repair	1.51	0.57, 4.03	0.41	0.82	0.33, 2.06	0.67
Craftsworkers	0	0, 999	0.99	0	0, 999	0.99
Service	0.34	0.08, 1.49	0.15	1.40	0.71, 2.77	0.33

a. Includes 47 acute cases, 83 chronic cases, and 1,948 controls.
b. OR=Odds ratio; 95% CI=95% confidence interval; p=p-value.
c. Quintiles based on distribution observed among all controls in the analysis set.
d. Referent category.
e. Includes widowed, divorced, and separated.
f. CMF=Career Management Field: support=support/administration; infantry=infantry/gun crews; e-m repair=electrical/mechanical equipment repair; service=service/supply; communication=communications/intelligence; electrical=electrical equipment repair; technical=technical/allied specialties.

When we instead restricted cases to those hospitalized for chronic knee conditions, we found that the age effect was stronger, but less precisely measured, than that we observed for the risk of any knee-related hospitalization. Odds ratios increased steadily with increasing quintile of age, from two for the 23-25 year-old relative to the 18-22 year-old women, to almost four among women in the oldest age group. The protective effect of non-white race was likewise stronger among this subgroup (OR=0.45; 95% CI, 0.28-0.72), while the magnitude of the marital status effect was similar in the subgroup to that we observed for all knee-related hospitalizations (Table 3.4d).

In contrast to the results we observed for the demographic characteristics, the associations between risk of hospitalization for chronic knee conditions and

occupational characteristics were substantially attenuated and more imprecise compared to the associations we observed in the main analysis. While women in the middle pay grade group (E4-E6) were still at lower risk of hospitalization for chronic knee conditions relative to women in the lowest pay grade group, (OR=0.68; 95% CI, 0.31-1.25), women in the highest pay grade group may be at higher risk relative to women in the lowest group (OR=1.14; 95% CI, 0.41-3.30). In the main analysis, each of the upper pay grade groups was associated with an approximately 50% lower risk relative to the lowest pay grade group (Table 3.4d). For all CMF relative to support/administration, the risk of hospitalization for chronic knee conditions was very close to 1.0. The most extreme ORs were for the service/supply CMF (OR=1.40; 95% CI, 0.71-2.77) and technical/allied specialties (OR=0.77; 95% CI, 0.18-3.36). However, the confidence intervals around these extreme point estimates are quite wide.

Tissue Type. Table 3.4e shows subgroup analyses according to the type of tissue involved in the injury. For nearly all terms included in the model, the risk of hospitalization for soft tissue injuries was either approximately the same as or more extreme than the risk associated with the same term in the main analysis. In contrast to the results for the soft tissue injuries, the effects we observed in the main analysis were substantially attenuated when we restricted attention to bony tissue injuries. Most of the point estimates from this model were close to the null value and measured with substantial imprecision.

Table 3.4e. Multivariable Logistic Regression Models: Risk Factors for Knee-Related Hospitalization among Women, Stratified by Tissue Type

	Soft Tissue Cases[a]			Bony Tissue Cases[a]		
	OR[b]	95% CI[b]	p[b]	OR[b]	95% CI[b]	p[b]
Age[c]						
18-22 years	1.0[c]	--	--	1.0[c]	--	--
23-25 years	1.78	1.17, 2.69	0.007	0.68	0.380 1.24	0.21
26-29 years	2.32	1.49, 3.60	0.002	0.97	0.52, 1.80	0.91
30-33 years	1.99	1.19, 3.33	0.009	1.09	0.54, 2.18	0.82
34-59 years	3.33	1.93, 5.75	<0.0001	1.10	0.49, 2.46	0.83
Race						
White	1.0[d]	--	--	--	--	--
Nonwhite	0.74	0.57, 0.96	0.02	0.65	0.44, 0.95	0.03
Marital status						
Single	1.0[d]	--	--	1.0[d]	--	--
Married	0.76	0.57, 0.96	0.02	0.65	0.44, 0.95	0.03
Formerly married[e]	0.55	0.32, 0.96	0.04	0.54	0.25, 1.17	0.12
Pay grade						
E1-E3	1.0[d]	--	--	1.0[d]	--	--
E4-E6	0.41	0.30, 0.57	<0.0001	0.71	0.43, 1.18	0.19
E7-E9	0.33	0.16, 0.69	0.003	1.09	0.40, 2.98	0.87
CMF[f]						
Infantry	1.75	0.57, 5.39	0.33	0.00	0, 999	0.99
Electrical	1.55	0.84, 2.85	0.16	0.83	0.29, 2.42	0.74
Communication	1.69	1.12, 2.55	0.01	1.37	0.76, 2.45	0.29
Healthcare	1.43	0.98, 2.10	0.07	1.28	0.75, 2.18	0.36
Technical	2.28	1.17, 4.45	0.02	2.20	0.88, 5.49	0.09
Support	1.0[d]	--	--	1.0[d]	--	--
E-M repair	1.80	0.99, 2.51	0.05	1.14	0.57, 2.32	0.71
Craftsworkers	1.05	0.23, 4.77	0.95	0	0, 999	0.99
Service	1.62	1.08, 2.44	0.02	1.35	0.76, 2.39	0.31

a. Includes 281 soft tissue cases, 122 bony tissue cases and 1,948 controls.
b. OR=Odds ratio; 95% CI=95% confidence interval; p=p-value.
c. Quintiles based on distribution observed among all controls in the analysis set.
d. Referent category.
e. Includes widowed, divorced, and separated.
f. CMF=Career Management Field: support=support/administration; infantry=infantry/gun crews; e-m repair=electrical/mechanical equipment repair; service=service/supply; communication=communications/intelligence; electrical=electrical equipment repair; technical=technical/allied specialties; non-occupational includes trainees, prisoners, and patients.

Surgical Status. We also categorized cases as surgical or non-surgical, based on the presence or absence of a knee-related procedure code in the hospital record (Appendix B). When we restricted the case series to the 241 that required surgery, we found that most of the terms in the model had similar point estimates to those derived from the main analysis (Table 3.4f). The effects estimated in the subgroup analysis were somewhat less precise than those from the main analysis, however, and the estimates for some of the terms were notably different. In particular, the risk of any knee-related hospitalization for women in the infantry/gun crews CMF relative to administration/support was 1.0 in the main analysis (95% CI, 0.33-3.02) and 0.44 when we considered surgical cases, alone (95% CI, 0.06-3.38). Similarly, the risk of any knee-related hospitalization was 44% higher among women in the electrical equipment

repair CMF compared to administration/support (95% CI, 0.86-2.39), but the risk of knee surgery was 77% higher in this CMF (95% CI, 0.87-3.22).

Table 3.4f. Multivariable Logistic Regression Models: Risk Factors for Knee-Related Hospitalization among Women, Stratified by Surgical Status

	Surgical Cases			Nonsurgical Cases		
	OR[b]	95% CI[b]	p[b]	OR[b]	95% CI[b]	p[b]
Age[c]						
18-22 years	1.0[c]	--	--	1.0[c]	--	--
23-25 years	1.35	0.88, 2.08	0.17	1.47	0.90, 2.40	0.13
26-29 years	1.58	0.99, 2.51	0.06	2.10	1.25, 3.52	0.01
30-33 years	1.51	0.89, 2.56	0.13	2.07	1.14, 3.75	0.02
34-59 years	2.05	1.15, 3.65	0.02	3.30	1.75, 6.22	0.002
Race						
White	1.0[d]	--	--	--	--	--
Nonwhite	0.64	0.48, 0.85	0.002	0.74	0.55, 1.00	0.05
Marital status						
Single	1.0[d]	--	--	1.0[d]	--	--
Married	0.83	0.61, 1.13	0.25	0.58	0.41, 0.82	0.002
Formerly married[e]	0.56	0.30, 1.04	0.07	0.49	0.27, 0.91	0.02
Pay grade						
E1-E3	1.0[d]	--	--	1.0[d]	--	--
E4-E6	0.49	0.35, 0.70	<0.0001	0.46	0.31, 0.67	<0.0001
E7-E9	0.39	0.17, 0.90	0.03	0.65	0.31, 1.37	0.26
CMF[e]						
Infantry	0.44	0.06, 3.38	0.43	1.70	0.48, 6.06	0.41
Electrical	1.77	0.87, 3.22	0.06	0.99	0.43, 2.28	0.99
Communication	1.27	0.81, 1.99	0.31	1.82	1.15, 2.86	0.01
Healthcare	1.35	0.90, 2.00	0.14	1.30	0.83, 2.03	0.25
Technical	1.46	0.66, 3.12	0.35	2.71	1.32, 5.55	0.007
Support	1.0[d]	--	--	1.0[d]	--	--
E-M repair	1.48	0.91, 2.41	0.11	1.16	0.64, 2.08	0.62
Craftsworkers	0.60	0.08, 4.62	0.62	0.75	0.10, 5.89	0.79
Service	1.46	0.95, 2.24	0.08	1.65	1.04, 2.62	0.03

a. Includes 241 surgical cases, 200 bony tissue cases, and 1,948 controls.
b. OR=Odds ratio; 95% CI=95% confidence interval; p=p-value.
c. Quintiles based on distribution observed among all controls in the analysis set.
d. Referent category.
e. CMF=Career Management Field: support=support/administration; infantry=infantry/gun crews; e-m repair=electrical/mechanical equipment repair; service=service/supply; communication=communications/intelligence; electrical=electrical equipment repair; technical=technical/allied specialties.

In an attempt to separate out the effects of duration of service and age, we re-ran this sub-analysis substituting duration of service quintiles for age quintiles. When pay grade was included in the model, we found too much collinearity among terms such that it was impossible to obtain stable estimates. When we also removed pay grade from the model, some of this instability was removed, but the Hosmer-Lemeshow goodness of fit test indicated an important degree of lack of fit, with p=0.02 for the test statistic (data not shown).

Two hundred of the women hospitalized for knee problems had no indication of surgery in their hospital records (Table 3.4f). For all terms in the final model, the point estimates were similar from the main analysis to the sub-group analysis. Like the

analysis restricted to surgical knee cases, mathematical problems arose when we substituted duration of service for age. These problems were not corrected by removing pay grade from the model (data not shown).

Men

Bivariate Frequency Distributions. As we observed among the women, there was a similar age distribution for male cases and controls (Table 3.2). Cases were slightly over represented in the second quintile of age, and slightly under represented in the fourth and fifth quintiles. Male cases were more likely than controls to be of white race, and were more likely to have never married and to have fewer dependents. Like the women, the majority of men were high school graduates both when education was assessed at enlistment and at the end of follow-up. Controls were slightly more likely than cases to have had other than a high school education (either less than 4 years of high school or some college). Also like the women, male cases were over represented among the lowest pay grades (E1-E3) and to have somewhat longer duration of service compared to male controls.

There were some notable differences in the distribution of CMFs for male cases and controls. Over 40% of cases were in jobs classified as infantry/gun crews, compared to 28% of controls. The next most common CMF for both cases and controls was electrical/mechanical equipment repair (16.5% and 15.7%, respectively), followed by communications/intelligence for the cases (10%) and support/administration (13.5%) for controls. Male cases were somewhat more likely than controls to be in jobs associated with greater amounts of lifting (151-175 pounds), running/walking (at least a quarter of a mile), climbing (40 feet), kneeling while shoveling or lifting, and standing. Cases were also more likely than controls to be in jobs classified as having very heavy physical demands.

Single Predictor Models. In preliminary single predictor logistic regression models, we observed a monotonically decreasing risk of hospitalization with increasing quintiles of age (Table 3.3). Nonwhite men experienced a 20% lower risk (95% CI, 0.67-0.97) compared to white men, a much smaller relative difference than that we observed among the women. Like women, married men were at lower risk of knee-related hospitalization (OR=0.65; 95% CI, 0.54-0.78) compared to single men. We observed a U-shaped pattern of risks associated with the number of dependents. Those with one dependent were at slightly increased risk relative to men with two dependents; having three dependents was associated with a decline in risk; and having four or more dependents was associated with increased risk of knee-related hospitalization. Levels of educational attainment other than having completed high school were associated with lower risk of knee-related hospitalization. This pattern held both when education was measured at entry into the Army and at the end of follow-up.

The patterns of risk associated with duration of service and pay grade among men were similar to the patterns we observed among the women. Increasing duration of service (up to 12 years) was associated with a three- to four-fold higher risk

compared to the lowest quintile of duration, and the highest quintile, 13-34 years of service, was associated with a 9-fold increase in risk of knee-related hospitalization. Relative to the lowest pay grade group, men in the middle and highest pay grades (E4-E6 and E7-E9) were at lower risk of hospitalization for knee problems. In comparison with the support/administration CMF, the majority of other CMF were associated with higher risks. The highest ORs we observed were for craftsworkers (OR=3.09; 95% CI, 1.18-8.08) and infantry/gun crews (OR=2.03; 95% CI, 1.49-2.78).

Several of the job tasks we evaluated were associated with higher risks of knee-related hospitalization in single predictor models. In particular, men in jobs associated with increasing amounts of lifting were at approximately double the risk compared to men in jobs with no lifting requirement; men in jobs associated with running or walking at least a quarter of a mile experienced a 60% increase in risk compared to men in jobs with no running/walking; and jobs requiring kneeling while lifting or shoveling led to nearly a 60% higher risk. All jobs with physical demand ratings other than "very heavy" were associated with an approximately 30% lower risk of knee-related hospitalization compared to jobs rated as having light physical demands.

Multivariable Modeling. Although the effects associated with quintiles of age met our criteria for statistical and practical importance when considered at the univariate level, we were unable to arrive at a stable multivariable model for the sociodemographic characteristics of the men in this study when we included age as a covariate. The base demographic model for men, therefore, contains race (white/nonwhite) and education at entry into the Army (≤ 4 years of high school or any college vs. high school graduate). The occupational characteristics included in the final model for the men were as follows: quintiles of duration of service (relative to the lowest quintile); CMF (each compared to support/administration); lifting (any vs. none); and the physical demand ratings assigned by the Army to each job code (heavy, moderately heavy, medium and light vs. very heavy).

As shown in Table 3.5a, after controlling for all other factors in the model, the risk of any knee-related hospitalization among non-white men was about 23% lower compared to the risk of knee-related hospitalization among white men (95% CI, 0.63-0.94). Men who had completed high school at the time of enlistment into the Army were at 25% to 50% higher risk of hospitalization for knee problems, compared to men who had any college education or had not completed high school, respectively.

Increasing duration of service quintiles were associated with a strong, monotonic trend toward increasing risk of knee-related hospitalization, ranging from OR=3.38 (95% CI, 2.23-5.10) for those with 3-4 years of service to more than 12 (OR=12.18; 95% CI, 8.17-18) for those with at least 13 years of service. When compared with the support/administration CMF, all other CMF were associated with at least a 20% higher risk of knee-related hospitalization. The CMF with the highest ORs were craftsworkers (OR=3.81; 95% CI, 1.35-11), healthcare (OR=2.91; 95% CI, 1.44-5.40), and electrical equipment repair (OR=2.79; 95% CI, 1.44-5.40).

Men in jobs associated with any amount of lifting were at more than 3 times the risk of knee-related hospitalization than men in jobs not associated with lifting (OR=3.21; 95% CI, 1.44-7.18). No particular trend with decreasing physical demand rating was apparent, although men with jobs rated "light demands" were at 80% lower risk of hospitalization for knee problems compared to men in jobs rated as having "very heavy" demands (95% CI, 0.05-0.84).

Evaluation of Effect Modification

Race. Race appears to be a powerful effect modifier for the men. Among whites, the risk of knee-related hospitalization was approximately halved for those with any level of education at enlistment other than having completed high school. In contrast, non-white men who had not completed high school at enlistment were at about 40% lower risk of knee-related hospitalization relative to those who had completed high school (OR=0.62; 95% CI, 0.32-1.18). Non-white men who had any college were at a 22% higher risk than non-white men who had completed high school (OR=1.22; 95% CI, 0.63-2.36, Table 3-5a).

Table 3.5a. Multivariable Logistic Regression Models: Risk Factors for Knee-Related Hospitalization among Men, Stratified by Race

	All Men[a]			White Men[a]			Nonwhite Men[a]		
	OR[b]	95% CI[b]	p[b]	OR[b]	95% CI[b]	p[b]	OR[b]	95% CI[b]	p[b]
Race									
White	1.0[c]	--	--	--	--	--	--	--	--
Nonwhite	0.77	0.63, 0.94	0.01	--	--	--	--	--	--
Education at entry[d]									
≤ High school	0.51	0.36, 0.72	<0.0001	0.47	0.31, 0.71	0.0004	0.62	0.32, 1.18	0.14
High school	1.0[c]	--	--	1.0[c]	--	--	1.0[c]	--	--
Any college	0.75	0.50, 1.13	0.17	0.56	0.33, 0.94	0.03	1.22	0.63, 2.36	0.56
Duration of service[e]									
1-2 years	1.0[c]	--	--	1.0[c]	--	--	1.0[c]	--	--
3-4 years	3.38	2.23, 5.10	<0.0001	2.89	1.81, 4.62	<0.0001	5.66	2.29, 14	0.0002
5-7 years	4.51	2.99, 6.79	<0.0001	4.83	3.04, 7.69	<0.0001	4.35	1.76, 11	0.002
8-12 years	4.86	3.24, 7.30	<0.0001	4.74	2.67, 7.57	<0.0001	6.29	2.60, 15	<0.0001
13-34 years	12	8.17, 18	<0.0001	11	6.63, 17	<0.0001	18	7.82, 45	<0.0001
CMF[f]									
Infantry	2.21	1.52, 3.21	<0.0001	2.45	1.40, 4.30	0.002	2.18	1.30, 3.65	0.0003
Electrical	2.79	1.44, 5.40	0.002	4.16	1.70, 10	0.002	1.55	0.55, 4.35	0.40
Communication	1.95	1.25, 3.03	0.003	2.39	1.29, 4.41	0.005	1.39	0.66, 2.92	0.38
Healthcare	2.91	1.34, 6.35	0.007	5.41	1.90, 16	0.002	1.34	0.38, 4.73	0.65
Technical	1.27	0.61, 2.62	0.53	1.60	0.64, 4.02	0.32	0.81	0.21, 3.12	0.76
Support	1.0[c]	--	--	1.0[c]	--	--	1.0[c]	--	--
E-M repair	1.42	0.93, 2.19	0.11	1.53	0.83, 2.82	0.18	1.58	0.83, 3.03	0.16
Craftsworkers	3.81	1.35, 11	0.01	4.59	1.35, 16	0.02	2.82	0.29, 28	0.37
Service	1.21	0.74, 1.98	0.45	1.40	0.69, 2.85	0.35	1.13	0.56, 2.31	0.73
Lifting									
None	1.0[c]	--	--	1.0[c]	--	--	1.0[c]	--	--
Any	3.21	1.44, 7.18	0.005	2.97	1.02, 8.63	0.05	3.22	0.89, 12	0.08
Demands									
Very heavy	1.0[c]	--	--	1.0[c]	--	--	1.0[c]	--	--
Heavy	0.66	0.36, 1.20	0.17	0.54	0.23, 1.24	0.15	0.84	0.36, 2.00	0.70
Moderately heavy	0.71	0.48, 1.05	0.09	0.64	0.38, 1.06	0.08	0.91	0.48, 1.74	0.78
Medium	0.91	0.51, 1.64	0.75	1.29	0.60, 2.79	0.52	0.56	0.21, 1.48	0.24
Light	0.20	0.05, 0.84	0.03	0.07	0.01, 0.66	0.02	0.59	0.08, 4.48	0.62

a. All men: N=2,574 (682 cases); White men: N= 1,722 (491 cases); Nonwhite men: N= 852 (191 cases).
b. OR=Odds ratio; 95% CI=95% confidence interval; p=p-value.
c. Referent category
d. Educational attainment at enlistment into the Army
e. Quintiles based on distribution observed among all controls in the analysis set.
f. CMF=Career Management Field: support=support/administration; infantry=infantry/gun crews; e-m repair=electrical/mechanical equipment repair; service=service/supply; communication=communications/intelligence; electrical=electrical equipment repair; technical=technical/allied specialties.

The strong, monotonic trend toward increasing risk of knee-related hospitalization with increasing quintile of duration of service that we observed for all men combined was repeated in the stratified analysis. Among white men, the point estimates for each of the quintiles were approximately the same as the point estimates from the main analysis, reflecting the preponderance of whites relative to non-whites in the population. Among non-white men, however, the effects associated with increasing duration of service were even stronger, ranging from a nearly 6-fold increase in risk among those with 3-4 years of service (OR=5.66; 95% CI, 2.29-14) to an 18-fold increase in risk for those with 13-34 years of service (OR=18; 95% CI, 7.82-45) relative to men with 1-2 years of service.

The patterns of risk across strata were fairly consistent when we considered CMF. Among white men, all of the CMF demonstrated higher risks of knee-related hospitalization relative to the support/administration CMF. Odds ratios ranged from 1.40 for service/supply (95% CI, 0.63-2.85) to 5.41 for healthcare (95% CI, 1.90-16). For all CMF, the point estimates were larger for the white men than for all men combined, although measured with less precision owing to the smaller number of observations. For white men, the CMF with the highest ORs relative to support/administration were healthcare, craftsworkers (OR=4.59; 95% CI, 1.35-16) and electrical equipment repair (OR=4.16; 95% CI, 1.70-10). For nonwhites, estimates associated with individual CMF were consistently lower and much less precise than those we observed for all men combined, ranging from 0.81 for men in the technical/allied specialties (95% CI, 0.21-3.12) to 2.82 for craftsworkers (95% CI, 0.29-28). The CMF with the highest ORs for nonwhite men were craftsworkers, infantry/gun crews (OR=2.18; 95% CI, 1.30-3.65) and electrical/mechanical equipment repair (OR=1.58; 95% CI, 0.83-3.03).

The risk of knee-related hospitalization for jobs associated with any lifting and for physical demand ratings were relatively consistent across strata. Regarding lifting, the odds ratios were 2.97 and 3.22 for whites and non-whites, respectively, for those in jobs associated with any lifting relative to those in jobs not associated with lifting. With respect to physical demand ratings, there was a suggestion that any demand rating other than "very heavy" was associated with a decrease in risk of knee-related hospitalization. The exception may be for white men in jobs rated as having "medium" physical demands, who appear to have a slightly higher risk (OR=1.29; 95% CI, 0.60-2.79).

Duration of Service. Duration of service acts as a modifier of the effects estimated for all terms remaining in the model (Table 3.5b). Among men in the lowest and highest duration of service categories (1-4 years and 13-34 years), the risk of knee-related hospitalization was similar for whites (OR=0.91; 95% CI, 0.60-1.37) and nonwhites (OR=0.90; 95% CI, 0.62-1.29). However, for men with 5-12 years of service, the risk of knee-related hospitalization was 40% lower among non-whites relative to whites (OR=0.62; 95% CI, 0.45-0.84).

Table 3.5b. Multivariable Logistic Regression Models: Risk Factors for Knee-Related Hospitalization among Men, Stratified by Duration of Service

	1-4 Years[a]			5-12 Years[a]			13-34 Years[a]		
	OR[b]	95% CI[b]	p[b]	OR[b]	95% CI[b]	p[b]	OR[b]	95% CI[b]	p[b]
Race									
White	1.0[c]	--	--	1.0[c]	--	--	1.0[c]	--	--
Nonwhite	0.91	0.60, 1.37	0.65	0.62	0.45, 0.84	0.002	0.90	0.62, 1.29	0.56
Education at entry[d]									
≤ High school	0.56	0.22, 1.44	0.23	0.35	0.20, 0.61	0.0003	0.71	0.42, 1.21	0.21
High school grad	1.0[c]	--	--	1.0[c]	--	--	1.0[c]	--	--
Any college	1.65	0.88, 3.21	0.12	0.43	0.20, 0.94	0.03	0.60	0.30, 1.19	0.14
Duration of service									
1-2 years	--	--	--	--	--	--	--	--	--
3-4 years	--	--	--	--	--	--	--	--	--
5-7 years	--	--	--	--	--	--	--	--	--
8-12 years	--	--	--	--	--	--	--	--	--
13-34 years	--	--	--	--	--	--	--	--	--
CMF[f]									
Infantry	2.91	1.14,7.42	0.03	4.71	2.40, 9.24	<0.0001	0.90	0.49, 1.65	0.73
Electrical	4.91	1.25, 19	0.02	7.33	2.53, 21	0.0002	0.60	0.16, 2.17	0.43
Communication	2.19	0.78, 6.11	0.14	3.35	1.57, 7.18	0.002	1.16	0.54, 2.48	0.71
Healthcare	2.89	0.60, 14	0.19	6.09	1.71, 22	0.005	3.13	0.65, 15	0.16
Technical	3.39	0.58, 20	0.18	2.18	0.62, 7.68	0.22	0.59	0.21, 1.70	0.33
Support	1.0[c]	--	--	1.0[c]	--	--	1.0[c]	--	--
E-M repair	1.51	0.53, 4.32	0.45	2.99	1.42, 6.28	0.008	0.69	0.34, 1.41	0.31
Craftsworkers	2.53	0.25, 25	0.43	6.04	1.48, 25	0.01	0	--	--
Service	1.69	0.54, 5.27	0.37	2.18	0.95, 5.00	0.07	0.62	0.26, 1.46	0.27
Lifting									
None	1.0[c]	--	--	1.0[c]	--	--	1.0[c]	--	--
Any	2.54	0.26, 24	0.42	11	1.24, 96	0.03	4.91	1.29, 19	0.02
Physical demands									
Very heavy	1.0[c]	--	--	1.0[c]	--	--	1.0[c]	--	--
Heavy	0.30	0.08, 1.09	0.07	0.62	0.24, 1.59	0.32	0.99	0.35, 2.77	0.98
Moderately heavy	0.63	0.29, 1.36	0.24	0.70	0.38, 1.27	0.24	0.77	0.37, 1.59	0.47
Medium	0.63	0.29, 1.36	0.24	1.32	0.51, 3.43	0.56	0.31	0.11, 0.88	0.03
Light	0	--	--	0	--	--	0.14	0.02, 1.15	0.07

a. Quintiles 1 and 2=1-4 years: N=987 (261 cases); quintiles 3 and 4=5-12 years: N=1,049 (310 cases); quintile 5=13-39 years: N=537 (111 cases).
b. OR=Odds ratio; 95% CI=95% confidence interval; p=p-value.
c. Referent category
d. Quintiles based on distribution observed among all controls in the analysis set.
e. Educational attainment at enlistment into the Army.
f. CMF=Career Management Field: support=support/administration; infantry=infantry/gun crews; e-m repair=electrical/mechanical equipment repair; service=service/supply; communications=communications/intelligence; electrical=electrical equipment repair; technical=technical/allied specialties.

The patterns of risk associated with educational attainment at entry into the service are not at all consistent across categories of duration of service. Among men with up to 4 years of service, entering the Army with less than a high school education was associated with a lower risk of knee-related hospitalization relative to those who had graduated high school (OR=0.56; 95% CI, 0.22-1.44), while having attended college was associated with a higher risk (OR=1.68; 95% CI, 0.88-3.21). Among men who had served for a longer time, those who had either less than or more than high school were at lower risk relative to the high school graduates. Of the three duration of

service groups, the estimates for the men with 5-12 years of service were the most extreme, and also measured with the most precision.

The effects we observed in the main analysis for risk of knee-related hospitalization according to CMF were generally stronger among men in the first two strata of duration of service. Like the overall analysis, the point estimates in these two strata for all CMF relative to support/administration exceeded 1.0. Although many of the confidence intervals excluded the null value, they were all quite wide. For those who had been in the Army for up to four years, we observed the most extreme ORs for men in the electrical equipment repair (OR=4.91; 95% CI, 1.25-19), technical/allied specialties (OR=3.39; 95% CI, 0.58-20) and healthcare (OR=2.89; 95% CI, 0.60-14) CMF. Among men with 5-12 years of service, the highest ORs were for those with jobs classified as electrical equipment repair (OR=7.33; 95% CI, 2.53-21), healthcare (OR=6.09; 95% CI, 1.71-22) or craftsworkers (OR=6.04; 95% CI, 1.48-25). Among men with 13-34 years of service, there were sparse data for some of the CMF. We were, therefore, unable to estimate coefficients for all of the CMF for men in this category. Among those CMF with enough data to calculate coefficients, most of the ORs were around 1.0, with an overall range between 0.60 and 3.1 and substantial imprecision in the estimates.

In the main analysis, we observed a tripling of risk for any knee-related hospitalization among men in jobs associated with any amount of lifting relative to men in jobs with no lifting. We noted a similar effect of being in a job associated with any lifting among men with 1-4 years of service (OR=2.54; 95% CI, 0.26-0.42), and among men with 13 or more years in the Army (OR=4.91; 95% CI, 1.29-19). However, among men with 5-12 years of service, those who had jobs associated with lifting had an eleven-fold higher risk of knee-related hospitalization than men in jobs without lifting (95% CI, 1.24-96).

The risks associated with physical demand ratings seemed to increase with decreasing demands for men with up to 12 years of service in the Army, although there was substantial imprecision in the point estimates. Relative to jobs with very heavy physical demands, men with 1-4 years of service had risks ranging from 0.3 (95% CI, 0.08-1.09) for jobs associated with heavy demand ratings to 0.63 (CI: 0.29-1.36) for jobs with medium demands ratings. There were no men with light physical demands and 1-4 years of service. The risks relative to men in jobs with very heavy demands ranged from 0.62 (95% CI, 0.24-1.59) to 1.32 (95% CI, 0.51-3.43) for men with 5-12 years of service in the same demand categories; again, there were no men with light physical demands and 5-12 years of service. In contrast, the risks associated with decreasing physical demand ratings displayed a monotonically decreasing trend for men with 13-34 years of service. Relative to those with jobs rated as having very heavy demands, risks ranged from 0.99 (95% CI, 0.35-2.77) for soldiers with heavy demand jobs to 0.14 (95% CI, 0.02-1.15) for those with light physical demands.

Age. As we observed for the women, duration of service and quintiles of age were strongly interrelated, with a Spearman correlation coefficient of r_{SP} (age, duration of service)=0.78. Reflecting this strong association, the patterns of effects across strata

of age were similar to those we observed across duration of service categories. However, many of the point estimates were substantially attenuated and rather imprecise in the age-specific analyses compared to the duration of service analysis (Table 3.5c).

Table 3.5c. Multivariable Logistic Regression Models: Risk Factors for Knee-Related Hospitalization among Men, Stratified by Age

	18-25 Years[a]			5-12 Years[a]			13-34 Years[a]		
	OR[b]	95% CI[b]	p[b]	OR[b]	95% CI[b]	p[b]	OR[b]	95% CI[b]	p[b]
Race									
White	1.0[c]	--	--	1.0[c]	--	--	1.0[c]	--	--
Nonwhite	0.83	0.63, 1.09	0.18	1.03	0.75, 1.40	0.88	0.46	0.22, 0.99	0.05
Education at entry[d]									
≤ High school	0.59	0.35, 1.00	0.05	0.74	0.45, 1.20	0.22	0.69	0.23, 2.08	0.51
High school	1.0[c]	--	--	1.0[c]	--	--	1.0[c]	--	--
Any college	1.69	0.85, 3.33	0.13	0.79	0.42, 1.48	0.47	0.89	0.36, 2.16	0.79
Duration of service									
1-2 years	--	--	--	--	--	--	--	--	--
3-4 years	--	--	--	--	--	--	--	--	--
5-7 years	--	--	--	--	--	--	--	--	--
8-12 years	--	--	--	--	--	--	--	--	--
13-34 years	--	--	--	--	--	--	--	--	--
CMF[f]									
Infantry	2.81	1.56, 5.07	0.0006	1.67	0.97, 2.86	0.06	0.79	0.26, 2.36	0.67
Electrical	3.16	1.27, 7.84	0.01	2.26	0.79, 6.44	0.13	0.30	0.02, 4.94	0.40
Communication	2.68	1.39, 5.18	0.003	1.14	0.56, 2.34	0.71	0.79	0.21, 3.03	0.73
Healthcare	3.08	1.09, 8.74	0.03	1.12	0.30, 4.15	0.87	0.93	0.08, 11	0.96
Technical	3.46	0.92, 13	0.07	2.20	0.81, 5.99	0.12	0.42	0.07, 2.42	0.33
Support	1.0[c]	--	--	1.0[c]	--	--	1.0[c]	--	--
E-M repair	1.75	0.91, 3.37	0.09	1.29	0.68, 2.43	0.44	0.50	0.13, 1.93	0.31
Craftsworkers	2.74	0.74, 10	0.13	2.65	0.45, 16	0.28	0	--	--
Service	1.44	0.69, 3.02	0.33	1.16	0.57, 2.38	0.69	0.35	0.07, 1.87	0.22
Lifting									
None	1.0[c]	--	--	1.0[c]	--	--	1.0[c]	--	--
Any	7.29	0.86, 62	0.07	0.62	0.19, 2.00	0.42	2.00	0.33, 12	0.46
Physical demands									
Very heavy	1.0[c]	--	--	1.0[c]	--	--	1.0[c]	--	--
Heavy	0.35	0.14, 0.85	0.02	1.07	0.45, 2.53	0.88	2.04	0.31, 14	0.46
Moderately heavy	0.80	0.49, 1.30	0.36	0.58	0.29, 1.14	0.12	0.86	0.21, 3.51	0.83
Medium	2.81	1.15, 6.85	0.02	0.60	0.22, 1.65	0.32	0.53	0.12, 2.31	0.37
Light	0	--	--	1.94	0.30, 13	0.49	0	--	--

a. Quintiles 1 and 2=1-4 years: N= 924 (220 cases); quintiles 3 and 4=5-12 years: N=1,155 (349 cases); quintile 5=13-39 years: N=495 (113 cases).
b. OR=Odds ratio; 95% CI=95% confidence interval; p=p-value.
c. Referent category
d. Quintiles based on distribution observed among all controls in the analysis set.
e. Educational attainment at enlistment into the Army.
f. CMF=Career Management Field: support=support/administration; infantry=infantry/gun crews; e-m repair=electrical/mechanical equipment repair; service=service/supply; communication=communications/intelligence; electrical=electrical equipment repair; technical=technical/allied specialties.

The reduced risk of knee-related hospitalization for nonwhite relative to white men persisted among those aged 18-25 (OR=0.83; 95% CI, 0.63-1.09) and 34-59 years (OR=0.46; 95% CI, 0.22-0.99). Interestingly, this otherwise consistent effect disappeared among men aged 26-33 years (OR=1.03; 95% CI, 0.75-1.40). The risks associated with education at entry into the Army were also modified by age. Among men 18-25 years old, the risk of any knee-related hospitalization was lower among

those with less than a high school education (OR=0.59; 95% CI, 0.35-1.00) and higher among those with any college (OR=1.69; 95% CI, 0.85-3.33) relative to men who had graduated from high school at enlistment. For 26-33 year old men, both of the non-referent categories of educational attainment were associated with an approximately 25% lower risk (OR=0.74; 95% CI, 0.45-1.20 and OR=0.79; 95% CI, 0.42-1.48, respectively). Among the 34-59 year old men, risk of knee-related hospitalization was about 30% lower for those with less than a high school education (OR=0.69; 95% CI, 0.23-2.08) and 11% lower for those with any college (OR=0.89; 95% CI, 0.36-2.16).

Whereas stratification by duration of service markedly increased the risk estimates associated with CMF, at least in the two lower categories, there was no material difference in the observed effect of CMF on the risk of knee-related hospitalization within age strata (Table 3.5c). As in the main analysis, all CMF were associated with moderate increases in risk of knee-related hospitalization when compared with the support/administration CMF. For men aged 18-25 years, the risks ranged from 1.44 for service/supply (95% CI, 0.69-3.02) to 3.46 for the technical/allied specialties (95% CI, 0.92-13). Among the 26-33 year olds, ORs ranged from 1.12 (95% CI, 0.30-4.15) for healthcare workers to 2.65 for craftsworkers (95% CI, 0.45-16). As we observed in the stratum defined by the longest duration of service, the risks associated with the various CMF compared to support/administration were greatly reduced among the oldest men in this study. In fact, in this stratum, all of the ORs were below 1.00, ranging from 0.30 for those in the electrical/equipment repair CMF (95% CI, 0.02-4.94) to 0.93 for healthcare workers (95% CI, 0.08-11).

The risk of knee-related hospitalization among men in jobs associated with any lifting was strongly influenced by age. Among the youngest men, the OR for any lifting relative to no lifting was 7.29 (95% CI, 0.86-62). In contrast, men aged 26-33 years old were at 40% lower risk if their jobs were associated with lifting (OR=0.62; 95% CI, 0.19-2.00) and the oldest men in jobs associated with any lifting had double the risk of knee-related hospitalization compared to those with no lifting (95% CI, 0.33-12).

The lack of a pattern associated with physical demand ratings persisted in the analysis stratified by age. The youngest men were at reduced risk of knee-related hospitalization if their jobs were rated as having heavy or moderately heavy compared to very heavy physical demands (OR=0.35; 95% CI, 0.14-0.85 and OR=0.80; 95% CI, 0.49-1.30, respectively), whereas those with medium physical demand ratings were at nearly 3 times higher risk compared to those with very heavy demand jobs (OR=2.81; 95% CI, 1.15-6.85). None of the men in the youngest age group had light demand jobs. Among men aged 26-33 years, ORs decreased from 1.07 to 0.6 for the first three physical demand categories, then increased to 1.94 for men in jobs rated as having light demands (95% CI, 0.30-13). The pattern for the oldest men was directly opposite, with the highest risks evident among those in jobs rated as having heavy demands (OR=2.04; 95% CI, 0.31-14) and the lowest risks among those with jobs rated as having medium physical demands compared to very heavy demand jobs (OR=0.53; 95% CI, 0.12-2.31).

In an attempt to separate the age and duration of service effects, we also created strata based on the cross-classification of these two characteristics. As may be expected, there were insufficient numbers of observations in the extremes of the cross-classification (young age, long duration of service and vice versa), so these data are not presented.

Subgroup Analyses. Based on the recorded diagnoses and procedures (Appendix B), 87 of the men with knee-related hospitalizations had conditions that could be classified as "acute," 74 had conditions that could be classified as "chronic," 340 cases involved only soft tissue, and 232 cases involved only bone. Subgroup analyses based on chronicity are presented in Table 3.5d, and analyses based on tissue type are shown in Table 3.5e.

Chronicity. In contrast to the lower risk for nonwhite men that we observed in the main analysis, there was no difference in risk of hospitalization for acute knee problems for nonwhite relative to white men (OR=0.97; 95% CI, 0.61-1.54, Table 3.5d). There was a suggestion that the lower risk of knee-related hospitalization for men who had other than a high school education persisted in the subgroup defined by acute knee problems. However, the substantial lack of precision in these estimates indicates that the data were also compatible with a null effect.

Table 3.5d. Multivariable Logistic Regression Models: Risk Factors for Knee-Related Hospitalization among Men, Stratified by Chronicity

	Acute Cases			Chronic Cases		
	OR[b]	95% CI[b]	p[b]	OR[b]	95% CI[b]	p[b]
Race						
White	1.0[c]	--	--	1.0[c]	--	--
Nonwhite	0.97	0.61, 1.54	0.89	0.50	0.29, 0.87	0.02
Education at entry[d]						
≤ High school	0.61	0.28, 1.37	0.23	0.68	0.30, 1.52	0.35
High school	1.0[c]	--	--	1.0[c]	--	--
Any college	0.88	0.34, 2.54	0.79	0.56	0.17, 0.84	0.34
Duration of service						
1-2 years	1.0[c]	--	--	1.0[c]	--	--
3-4 years	4.65	1.55, 14	0.006	6.06	1.76, 21	0.004
5-7 years	6.23	2.10, 18	0.001	6.05	1.72, 21	0.005
8-12 years	4.63	1.51, 14	0.007	8.17	2.38, 28	0.008
13-34 years	14	4.84, 40	<0.0001	12	3.48, 41	<0.0001
CMF[e]						
Infantry	3.47	1.27, 9.47	0.02	1.65	0.65, 4.16	0.30
Electrical	1.41	0.27, 7.39	0.69	1.48	0.28, 7.82	0.65
Communication	1.59	0.46, 5.49	0.47	0.93	0.28, 3.13	0.91
Healthcare	1.47	0.17, 13	0.72	3.22	0.46, 22	0.24
Technical	0.98	0.11, 8.98	0.99	2.50	0.65, 10	0.18
Support	1.0[c]	--	--	1.0[c]	--	--
E-M repair	2.10	0.68, 6.43	0.20	0.79	0.25, 2.46	0.68
Craftsworkers	11	1.70, 66	0.01	4.00	0.41, 38	0.23
Service	0.90	0.23, 3.49	0.88	0.92	0.26, 3.19	0.89
Lifting						
None	1.0[c]	--	--	1.0[c]	--	--
Any	4.00	0.32, 49	0.28	999	--	--
Physical demand						
Very heavy	1.0[c]	--	--	1.0[c]	--	--
Heavy	1.66	0.41, 6.72	0.48	1.16	0.28, 4.74	0.84
Moderately heavy	1.37	0.60, 3.13	0.46	0.80	0.30, 2.15	0.66
Medium	0.92	0.18, 4.77	0.92	1.05	0.26, 4.23	0.94
Light	0	--	--	0	--	--

a. Includes 87 acute cases, 74 chronic cases, and 2,353 controls
b. OR=Odds ratio. 95% CI=95% confidence interval. p=p-value.
c. Referent category.
d. Education at entry into the Army.
e. CMF=Career Management Field: support=support/administration; infantry=infantry/gun crews; e-m repair=electrical/mechanical equipment repair; service=service/supply; communication=communications/intelligence; electrical=electrical equipment repair; technical=technical/allied specialties; non-occupational includes trainees, prisoners, and patients

With respect to occupational characteristics, the overall pattern of effects in the subgroup was similar to that which we observed in the main analysis, with many of the estimates derived from the subgroup at least as extreme as those we observed in the main analysis. However, with only 87 cases included in the subgroup analysis, most of the estimates were, not surprisingly, quite imprecisely measured. The risk of hospitalization for an acute condition increased sharply with increasing quintile of duration of service, from 4.65 among men with 3-4 years experience (95% CI, 1.55-14) to 14 among those with 13 or more years of service (95% CI, 4.84-40) relative to men who had been in the Army for 1-2 years. Compared to the support/administration CMF,

the CMF associated with the highest risks for acute knee injury were craftsworkers (OR=11; 95% CI, 1.7-66), infantry/gun crews (OR=3.47; 95% CI, 1.27-9.47) and electrical/mechanical equipment repair (OR=2.1; 95% CI, 0.68-6.43). Men in jobs associated with any lifting were at a similar level of risk for acute knee injury to that which we observed in the main analysis, with an OR of 4.00 (95% CI, 0.3-49). The risk for acute knee injury appeared to decline with decreasing physical demand ratings, from 1.66 for heavy demand relative to very heavy demand jobs (95% CI, 0.41-6.72) to 0.92 for medium demand jobs (95% CI, 0.18-4.77). However, the confidence intervals associated with these estimates are quite wide, making any meaningful interpretation of the results difficult.

We re-ran the final model for the subgroup of acute knee injury cases, substituting quintiles of age for duration of service (data not shown). The pattern of risks associated with the terms remaining in the model was similar, though the estimates were generally attenuated when we substituted in age. For 4 covariates, there was a suggestion that the effects may have been reversed when we substituted age for duration of service. These covariates were a) having completed any college vs. having completed high school at entry into the Army (OR=1.15; 95% CI, 0.44-2.97); b) being in the healthcare CMF vs. the support/administration CMF (OR=0.84; 95% CI, 0.10-7.02); c) being in the technical/allied specialties CMF vs. support/administration (OR=1.42; 95% CI, 0.16-13); and d) being in a job associated with any lifting vs. no lifting (OR=1.66; 95% CI, 0.14-20). As can be seen from the wide confidence intervals associated with these estimates, however, the data may also be interpreted as showing no difference from the null value or being no different from the estimates derived from the model that included duration of service rather than age.

When we restricted our analyses to the 74 cases hospitalized for chronic knee conditions, we again observed a pattern of risks that was generally similar to that seen in the main analysis. There was additional imprecision in the subgroup, however, due to the smaller number of observations included. Possible reversals of effect occurred for three of the CMF (relative to support/administration: communications/intelligence, OR=0.93; 95% CI, 0.28-3.13; electrical/mechanical equipment repair, OR=0.79; 95% CI, 0.25-2.46; and service/supply, OR=0.92; 95% CI, 0.26-3.19) and for men in jobs with heavy physical demand ratings relative to very heavy demands (OR=1.16; 95% CI, 0.28-4.74). These results are shown in Table 3.5d.

As we did for the subgroup of acute cases, we attempted to separate out the effects of duration of service and age by re-running the sub-analysis of chronic cases substituting quintiles of age for quintiles of duration of service. The risk of hospitalization for a chronic knee condition seems to decline with increasing quintiles of age in this population, though the pattern of risks was certainly not monotonic. Relative to the 18-22 year old men, the 23-25 year old men were at about a 15% lower risk (OR=0.84; 95% CI, 0.46-1.51). The 26-29 year old and 34-59 year old men were at 60% lower risk than 18-22 year olds (OR=0.36; 95% CI, 0.13-0.85 and OR=0.37; 95% CI, 0.17-0.81, respectively), while those aged 30-33 were at 30% lower risk (OR=0.73; 95% CI, 0.35-1.53) compared to 18-22 year olds. There were no striking differences in the effect estimates for the other terms in the model (data not shown).

Tissue Type. Three hundred and forty of the cases of knee-related hospitalization had conditions that affected soft tissue, only. Once again, although some point estimates for individual covariates were higher and others lower than those derived from the main analysis, the overall pattern of risks associated with the terms included in the final model were similar in the subgroup (Table 3.5e). When we substituted quintiles of age for duration of service, we found that the point estimates of effect were, in general, attenuated and less precisely measured. The effect of age on the risk of hospitalization for soft tissue knee injury seemed to be restricted to men in the oldest age group, 34-59 years. These soldiers were at nearly 60% lower risk than men aged 18-22 years (OR=0.44; 95% CI, 0.27, 0.70). The primary difference from the main analysis in this subgroup was for men in jobs associated with any lifting. When cases were restricted to soft tissue injuries and the model included age rather than duration of service, the three-fold increase in risk otherwise noted for men in jobs associated with lifting was reduced to 1.1 (95% CI, 0.41-2.98, data not shown).

Table 3.5e. Multivariable Logistic Regression Models: Risk Factors for Knee-Related Hospitalization among Men, Stratified by Tissue Type

	Soft Tissue Cases [a]			Bony Tissue Cases[a]		
	OR[b]	95% CI[b]	p[b]	OR[b]	95% CI[b]	p[b]
Race						
White	1.0[c]	--	--	1.0[c]	--	--
Nonwhite	0.68	0.52, 0.88	0.004	0.91	0.68, 1.23	0.53
Education at entry[d]						
≤ High school	0.64	0.42, 0.96	0.03	0.35	0.19, 0.67	0.001
High school	1.0[c]	--	--	1.35	--	--
Any college	0.87	0.53, 1.41	0.57	0.66	0.35, 1.25	0.20
Duration of service						
1-2 years	1.0[c]	--	--	1.0[c]	--	--
3-4 years	3.13	1.75, 5.61	<0.0001	3.59	2.00, 6.50	<0.0001
5-7 years	5.25	3.00, 9.22	<0.0001	3.95	2.17, 7.20	<0.0001
8-12 years	6.10	3.49, 11	<0.0001	3.71	2.03, 6.78	<0.0001
13-34 years	15	8.37, 25	<0.0001	8.84	4.94, 16	<0.0001
CMF[e]						
Infantry	1.90	1.20, 3.00	0.006	2.76	1.49, 5.09	0.001
Electrical	3.25	1.45, 7.29	0.004	1.83	0.61, 5.46	0.28
Communication	1.71	0.99, 2.97	0.06	2.42	1.19, 4.91	0.01
Healthcare	2.41	0.90, 6.45	0.08	4.84	1.49, 16	0.009
Technical	0.89	0.34, 2.35	0.81	2.40	0.88, 6.53	0.09
Support	1.0[c]	--	--	1.0[c]	--	--
E-M repair	1.31	0.77, 2.23	0.31	1.54	0.76, 3.13	0.24
Craftsworkers	3.29	0.84, 13	0.09	6.57	1.77, 25	0.005
Service	1.04	0.56, 1.93	0.91	1.62	0.74, 3.54	0.22
Lifting						
None	1.0[c]	--	--	1.0[c]	--	--
Any	2.87	1.06, 7.76	0.04	3.71	1.04, 13	0.04
Physical demands						
Very heavy	1.0[c]	--	--	1.0[c]	--	--
Heavy	0.36	0.15, 0.87	0.02	1.32	0.60, 2.93	0.50
Moderately heavy	0.82	0.50, 1.32	0.41	0.59	0.32, 1.08	0.09
Medium	0.73	0.34, 1.56	0.42	0.92	0.35, 2.41	0.86
Light	0.13	0.01, 1.20	0.07	0.28	0.04, 1.75	0.17

a. Includes 340 soft tissue cases, 232 bony tissue cases, and 2,353 controls
b. OR=Odds ratio; 95% CI=95% confidence interval; p=p-value.
c. Referent category.
d. Education at entry into the Army.
e. CMF=Career Management Field: support=support/administration; infantry=infantry/gun crews; e-m repair=electrical/mechanical equipment repair; service=service/supply; communication=communications/intelligence; electrical=electrical equipment repair; technical=technical/allied specialties.

Bony tissue injuries accounted for 232 of the cases (Table 3.5e). As we saw when analyzing acute cases, the otherwise persistent protective effect of non-white race on the risk of injury all but disappeared when we restricted to the subgroup with bony tissue injuries (OR=0.91; 95% CI, 0.68-1.23). The estimated effects associated with educational attainment other than high school were both more extreme and less precisely measured in the subgroup compared to the main analysis. The risk of bony tissue injury for men with less than a high school diploma was 0.35 (95% CI, 0.19-0.67), while that for men with any college at entry into the Army was 0.66 (95% CI, 0.32-1.25) compared to men who had completed high school.

The risk of bony tissue injury was strongly related to duration of service, but there was a suggestion that the risk remained steady, with an odds ratio of three or four, for men with up to 12 years of service compared to those with up to 2 years of service. Soldiers who remained in the Army for more than 12 years experienced an almost nine-fold increase in risk of bony tissue injury (OR=8.84; 95% CI, 4.94-16).

As in the main analysis, all CMF groups were associated with an increase in risk of bony tissue injury compared to the support/administration CMF. The magnitude of the effects were generally similar in the subgroup compared to the main analysis, but three of the CMF demonstrated substantially higher risks for the subgroup. These CMF were healthcare (OR=4.84; 95% CI, 1.49-16); technical/allied specialties (OR=2.40; 95% CI, 0.88-6.53); and craftsworkers (OR=6.57; 95% CI, 1.77-25). Although the confidence intervals for these estimates exclude the null value, they are quite wide; the data are also compatible with effects identical to those we observed in the main analysis.

When we substituted quintiles of age for duration of service categories, we again noted a general attenuation of the estimated effects, along with a decrease in precision. There were exceptions, however. Among men in the technical/allied specialties CMF, the risk of injury changed from 1.50 to 3.64 when we substituted age for duration of service (95% CI, 1.34-9.88). The OR associated with medium physical demands increased from 0.92 to 1.24 (95% CI, 0.47-3.27), while that for light demands increased from 0.13 to 0.99 (95% CI, 0.16-6.16) with the substitution of age for duration of service (data not shown).

In spite of the strong correlation between age and duration of service, we noted a decline in risk of bony tissue injuries with increasing quintiles of age. The decline with age contrasts with the strong increase in risk of injury with increasing duration of service. Compared to 18-22 year old men, those in the 23-25 and 26-29 year age groups each experienced a 14% lower risk of bony tissue injury (95% CI, 0.60-1.25 and 0.59-1.25, respectively). Men aged 30-33 years had 27% lower risk than the youngest men (95% CI, 0.32-0.88), while the men in the oldest age group had a 61% lower risk compared to the youngest men (95% CI, 0.22-0.67, data not shown).

Surgical Status. Table 3.5f shows the results of the model restricted to the 381 knee-related hospitalizations that included a surgical procedure to the knee. The pattern of risks we observed in this subgroup was consistent, again, when compared with the pattern we saw in the main analysis. The most striking difference from the main analysis was for the risk associated with having less than a high school education at entry into the service. Men in this category had a 70% lower risk relative to men with a high school degree (OR=0.29; 95% CI, 0.17-0.49). Two of the CMFs also showed substantial changes in risk estimates compared to those we observed in the main analysis. These were the healthcare CMF (OR compared to support/ administration=4.65; 95% CI, 1.86-12) and craftsworkers (OR=6.13; 95% CI, 2.09-18). Substituting age for duration of service into the model restricted to surgical knee cases again resulted in a general attenuation and decrease in precision of the effect estimates (data not shown).

Table 3.5f. Multivariable Logistic Regression Models: Risk Factors for Knee-Related Hospitalization among Men, Stratified by Surgical Status

	Surgical Cases[a]			Nonsurgical Cases[a]		
	OR[b]	95% CI[b]	p[b]	OR[b]	95% CI[b]	p[b]
Race						
White	1.0[c]	--	--	1.0[c]	--	--
Nonwhite	0.82	0.64, 1.05	0.01	0.70	0.52, 0.96	0.03
Education at entry[d]						
≤ High school	0.65	0.39, 1.08	0.10	0.91	0.60, 1.40	0.66
High school	1.0[c]	--	--	1.0[c]	--	--
Any college	0.65	0.39, 1.08	0.10	0.93	0.53, 1.64	0.80
Duration of service						
1-2 years	1.0[c]	--	--	1.0[c]	--	--
3-4 years	3.79	2.24, 6.64	<0.0001	2.82	1.51, 5.29	0.001
5-7 years	5.10	3.02, 8.59	<0.0001	3.82	2.06, 7.10	<0.0001
8-12 years	5.20	3.08, 8.78	<0.0001	4.48	2.45, 8.20	<0.0001
13-34 years	14	8.41, 23	<0.0001	9.41	5.20, 17	<0.0001
CMF[e]						
Infantry	2.22	1.41, 3.52	0.001	2.14	1.22, 3.74	0.001
Electrical	3.61	1.60, 8.09	0.002	1.74	0.64, 4.75	0.28
Communication	1.92	1.11, 3.30	0.02	1.97	1.02, 3.80	0.04
Healthcare	4.65	1.86, 12	0.001	1.22	0.34, 4.40	0.76
Technical	1.08	0.43, 2.74	0.86	1.49	0.59, 4.11	0.44
Support	1.0[c]	--	--	1.0[c]	--	--
E-M repair	1.33	0.78, 2.28	0.29	1.55	0.82, 2.92	0.18
Craftsworkers	6.13	2.09, 18	0.001	0	0, 99	0.99
Service	1.34	0.73, 2.45	0.34	1.01	0.47, 2.15	0.99
Lifting						
None	1.0[c]	--	--	1.0[c]	--	--
Any	6.77	2.26, 20	0.001	1.11	0.35, 3.54	0.86
Physical demands						
Very heavy	1.0[c]	--	--	1.0[c]	--	--
Heavy	0.48	0.22, 1.03	0.06	1.10	0.46, 2.58	0.84
Moderately heavy	0.66	0.40, 1.07	0.09	0.81	0.45, 1.43	0.46
Medium	0.82	0.39, 1.71	0.59	0.99	0.42, 2.22	0.98
Light	0.20	0.04, 0.86	0.03	0	0, 999	0.99

a. Includes 381 surgical cases, 232 nonsurgical cases, and 2,353 controls
b. OR=Odds ratio. 95% CI=95% confidence interval. p=p-value.
c. Referent category.
d. Education at entry into the Army.
e. CMF=Career Management Field: support=support/administration; infantry=infantry/gun crews; e-m repair=electrical/mechanical equipment repair; service=service/supply; communication=communications/intelligence; electrical=electrical equipment repair; technical=technical/allied specialties.

Two hundred and thirty-two of the cases had no evidence of a knee-related surgical procedure (Table 3.5f). As before, there was a protective effect associated with non-white race in this sub-analysis (OR=0.70; 95% CI, 0.52-0.96, non-white men relative to white men). The protective effect associated with levels of educational attainment other than high school that persisted in all other analyses apparently does not operate in this subgroup; the point estimates for men with either less than or more than a high school education were not appreciably different from the null value.

The risk of non-surgical knee-related hospitalization was strongly associated with increasing quintile of duration of service, with a positive, monotonic trend ranging from 2.82 for men with three to four years of service (95% CI, 1.51-5.29) to 9.41 for men with

at least 13 years of service (95% CI, 5.20-17) compared to those who had been in the Army for up to 2 years. Except for lifting, the estimated effects for each of the other occupational characteristics in the model were similar or slightly attenuated in the subgroup compared with the main analysis, and measured with less precision. The otherwise consistent three-fold increase in risk for men in jobs associated with any lifting was not apparent in the subgroup analysis. The risk of a non-surgical, knee-related hospitalization was nearly the same for men in jobs associated with any lifting compared to men in jobs not associated with lifting (OR=1.11; 95% CI, 0.35-3.54).

The substitution of quintiles of age for duration of service resulted in a mild attenuation of the protective effect of non-white race (OR=0.81; 95% CI, 0.60-1.09) and an apparent reversal of the effect of educational attainment. When controlling for age, the risk of non-surgical, knee-related hospitalization appears to be about 20% higher among men with other than a high school degree at entry into the service (OR=1.24; 95% CI, 0.81-1.89 for less than 4 years of high school and OR=1.22; 95% CI, 0.69-2.16 for any college, data not shown).

Increasing age, itself, appears to be associated with a decline in risk of non-surgical, knee-related hospitalization. There was no real change in risk for men aged 23-25 years compared with 18-22 year old men (OR=1.05; 95% CI, 0.73-1.50). However, men aged 26-29 years and 30-33 years had an approximately 30% lower risk relative to the youngest soldiers (OR=0.71; 95% CI, 0.47-1.06 and OR=0.73; 95% CI, 0.46-1.16, respectively), while the oldest men had a more than 50% lower risk (OR=0.47; 95% CI, 0.28-0.79, data not shown).

Consistent with our other analyses, controlling for age resulted in a general attenuation and decrease in precision of the estimated risks associated with the various CMF and with physical demand ratings. Unlike the other analyses, the risk of a non-surgical, knee-related hospitalization for men in jobs associated with any lifting may have reversed direction after controlling for age. The odds ratio for men in jobs associated with lifting was 0.45 (95% CI, 0.14-1.47).

DISCUSSION

Although relying heavily on descriptive analyses, previous investigations have identified risk factors for various types of acute musculoskeletal injury. Accepted determinants of acute occupational knee injuries include female gender, increasing age, body size or composition, physical fitness and prior injury (15, 16, 27-29, 35, 36, 39, 41, 43-45, 50, 65). Relations between specific work exposures and knee injury have been less thoroughly studied. These investigations have tended to focus on the development of chronic knee conditions, and have produced inconsistent results. However, overall occupational physical demands, kneeling, squatting and stair climbing have been implicated as risk factors (15, 22, 33, 39, 43, 44, 62, 65).

The main goal of this analysis was to evaluate occupational risk factors for knee injury while taking into account demographic characteristics. All of these analyses were stratified by gender, since our previous work indicated that men and women experience

different risks of knee-related disability discharge from the U.S. Army (49, 58, 64). We also expected to identify differences in risk according to race/ethnicity, age and duration of service. In addition to these personal characteristics, we evaluated differences in risk for subgroups of cases defined by the chronicity, tissue type and surgical status of the injury.

We found limited evidence of effect modification, to the extent that the point estimates of effect observed in the main analyses were magnified or attenuated in the stratified and subgroup analyses. Unfortunately, the reduced number of cases included in some of the subgroups led to problems arising from sparse data and empty cells. However, in spite of the heterogeneity in the magnitude and precision of the point estimates and the lack of power in some of the subanalyses, the direction of the effects we observed demonstrated a remarkable degree of consistency across groups.

Among women, we noted an increase in risk of knee-related hospitalization with increasing quintiles of age in the main analysis and across strata defined by race. There was also an increase in risk of hospitalization for chronic knee injury with increasing age, for soft tissue cases and for both surgical and non-surgical cases. There was no association with age for acute knee injury, nor for injuries to bone. This pattern of effects seems reasonable, since chronic conditions, by definition time-related, are expected to be associated with age. Chronic conditions are also more likely to involve soft tissue rather than bone, while the reverse is true for acute injuries. However, since soft tissue injuries are more likely to need surgical repair than are injuries to bone, we would have expected the age effect to be either stronger in or limited to surgical vs. non-surgical cases.

Among both women and men, there was an important reduction in risk of knee-related hospitalization for nonwhites relative to whites. The reduction in risk persisted in nearly all of the subgroups we analyzed, except as follows: upon stratification by duration of service, the race effect disappeared for women with more than 13 years of service, and among men with 5-12 years of service. When we stratified by age instead of duration of service, the race effect was evident only for women in the two youngest age groups; it disappeared for the oldest women. Among men, also, only those in the youngest age group had risks that differed by race. The similarity in risk patterns across categories of age and duration of service is to be expected, given the strong, positive correlation between these two covariates. Among women, the protective effect of nonwhite race persisted in all other subgroups of cases (defined by tissue type, chronicity and surgical status). Among men, the protective effect of nonwhite race was evident among those with chronic knee conditions and soft tissue injuries. The race effect was also present in subgroups defined by surgical status for both men and women.

Most prior studies of occupational injury were restricted to populations consisting of one racial/ethnic group; we identified a small number of studies that evaluated racial differences in risk. In the civilian sector, a review of data from the National Health Interview Survey from the middle 1980s showed that, among working adults, blacks had fewer injuries overall than whites. When at-work injuries were considered separately,

the overall rates for whites and blacks were similar, but racial differences in injury rates were noted within particular industries. Specifically, there was a tendency for blacks in service or blue-collar occupations to have lower at-work injury rates compared to whites in the same sectors (63). In contrast, there were no racial differences in the prevalence of osteoarthritis of the knee among participants in the First National Health and Nutrition Examination Survey (17). Although previous traumatic injury is an important risk factor for the development of osteoarthritis (15), it should be recognized that the two are not synonymous. Data on racial differences in injury rates are similarly lacking among military personnel. In a study of injuries reported among members of a basic training class, blacks have about a 30% lower risk than whites after controlling for gender, age and physical fitness measures (12). The observed racial differences in injury rates were even more marked in analyses stratified by gender. After controlling for physical fitness measures, black men were at 30% lower risk than white men, while black women were at 80% lower risk compared to white women (11).

Married and formerly married women were consistently at lower risk of knee-related hospitalization than single women, an association that is unlikely to have a biological basis and has not been previously documented. Rather, marital status may be acting as a surrogate for some other characteristic. Although the marital status effect persisted in all subgroups, it was attenuated for the women in the oldest age category when we stratified the study group by age. In general, younger women are more likely to be single than older women. Likewise, in this study group, the proportion of single women in each of the first three age categories was 76%, 52%, and 36%, respectively (data not shown). The range of ages covered by the first three quintiles is relatively narrow, 18-29 years. In contrast, the majority of women aged 30-33 years and 34-49 years were married (62% in both age quintiles, data not shown). The attenuation of the marital status effect for the women in the oldest (and widest) age group suggests that marital status may be standing in for age in the overall model. There may be some residual confounding by age partially accounted for by including the term for marital status in the overall model for women.

The level of educational attainment at entry into the Army was a consistent determinant of risk for men in this study. Among nearly all of the subgroups we considered, we found a reduction in risk for men who had either less than or more than a high school education. The reduced level of risk for men with other than a high school education was evident across most strata defined by race, duration of service and age, even after controlling for CMF, lifting and physical demand ratings. There were three exceptions to the pattern of reduced risks. Men with any college were at slightly increased risk of knee-related hospitalization if they were non-white, if they were in the lowest duration of service quintile (1-4 years), or if they were in the youngest age group (18-25 years). The education effect persisted across categories defined by chronicity and by the type of tissue involved in the injury. There was also a reduced risk of hospitalization requiring knee surgery among men with other than a high school education. Educational attainment was not associated with the risk of non-surgical knee hospitalization.

As with the marital status effect we observed among women, associations between educational attainment and knee injury are unlikely to be biologically based. Rather, we expect that educational attainment at entry into the Army may be associated either with lifestyle (e.g., leisure time activities) or occupational exposures that influence the likelihood of knee injury. Studies in the civilian sector have suggested that the rate of physician-diagnosed osteoarthritis of the knee may be negatively related to educational attainment. However, the effect was attenuated once further sociodemographic characteristics were taken into account, and the authors suggest that education may be related to symptom reporting or access to medical care (25). In contrast to the civilian setting, medical care is equally available to all Army personnel, so variability in access to care is not a likely alternative explanation for observed differences in injury rates in this population. We cannot, however, rule out differences in care seeking or symptom reporting behaviors that may be related to educational attainment.

Among women, increasing pay grade was negatively associated with knee injury in most of the analyses that we conducted. This contrasts with the increase in risk of knee injury that we noted with increasing age, and in spite of the positive correlation between age and pay grade (r_{SP}=0.59). The decline in risk with increasing pay grade was evident in all subgroups we considered except for women at or above the E7 level who were non-white, or hospitalized for chronic knee conditions or for injuries to bony tissue. There was no association with pay grade in these specific subgroups. Since there tends to be wide latitude in the specific responsibilities assigned to individuals within a given CMF or job, it is possible that personnel of higher pay grade are placed under lighter physical demands than those with the same job title or CMF who have a lower pay grade. Such a scenario might explain the observed reduction in risk of knee injury with increasing pay grade.

Duration of service was positively associated with risk of knee-related hospitalization among the men. This association persisted in all stratified and subgroup analyses. Duration of service was among the covariates closely associated with age, with a Spearman correlation coefficient of 0.78. If duration of service acts as a surrogate for age in these models, then this association among the men would parallel the positive association between risk of knee injury and increasing age that we noted among the women.

The collinearity between age, duration of service, and many of the other occupational characteristics we evaluated rendered it impossible to include age in the multivariable models we constructed for the men. However, because of their strong interrelation, we may have substantially controlled for age-related effects in analyzing occupational risk factors for knee injury by including duration of service in the analyses. Since nearly all of the associations we noted were attenuated when we substituted age for duration of service either as a stratification variable or as a covariate in the subanalyses, there is almost certainly some residual confounding by age or factors related to age in the main analyses for the men.

The Army frequently categorizes jobs according to CMFs. This strategy collapses thousands of job titles to 11 CMFs. While beneficial from the perspective of enhanced statistical power and reduced complexity of model building, it seems that this reduction in job titles may result in too great a loss of information for CMF to be a useful analytical tool. Other than a general increase in risk relative to the support/administration CMF, the associations between the individual CMF and the risk of knee injury showed little consistency across the stratified or subgroup analyses for either the men or the women.

For the men in this study, we included two additional occupational characteristics as covariates in the final multivariable model. These were lifting and physical demand ratings. Among men in jobs associated with any lifting, the odds of suffering a knee injury were approximately tripled in nearly every analysis we performed. We saw no association between lifting and risk of knee injury among 26-33 year old men in analyses stratified by age, and we saw no association between lifting and risk of non-surgical knee hospitalizations.

Physical demand ratings seemed to exert a weak independent effect on the risk of knee injury, although the ratings assigned are based on upper body strength requirements and the Spearman correlation between lifting and physical demand rating was 0.68 (not shown). Even after controlling for lifting, there was a suggestion of a positive association between increasing physical demand rating and the risk of knee injury.

In contrast to our findings that work exposures are relatively minor determinants of knee injury in the U.S. Army, some authors suggest that such factors may play a more important role than intrinsic worker characteristics. In separate reviews of research on occupational upper extremity disorders, Armstrong et al. and Hatch and Moline note that gender and other sociodemographic differences in risk tend to disappear after controlling for work exposures (9, 26). Blue, in another literature review, points to evidence that strength and endurance are similar among men and women after controlling for age, body size and composition, and physical fitness measures (13).

Most of the work exposures included in the TAIHOD represent ecological level measures. CMFs, physical demand ratings and job tasks are all mapped from job codes, which may or may not accurately reflect the work tasks being performed. Consequently, we expect exposure misclassification in these data. The mapping of exposures to job codes was based on information recorded in a centralized procedure manual (19) and was done in an identical manner for every record included in the data library (64). The bias towards the null resulting from this nondifferential misclassification may explain the relative lack of importance of work exposures in these analyses.

The results presented here suggest several avenues for future research. One is in the area of exposure assessment. Obtaining individual level information about job tasks and physical demands may add substantially to our ability to identify subgroups at high risk of knee injury. A second avenue of inquiry entails obtaining outpatient data in order to capture information about knee injuries that were not severe enough to require

hospitalization, but that may ultimately develop into chronic, job-threatening conditions. Next, we need to consider the possibility of residual confounding by factors associated with age, duration of service and pay grade in the models already developed. In addition, still unmeasured factors may play a role in the susceptibility to knee injury. These include physical attributes (e.g., height, weight, fitness, and strength) and lifestyle characteristics (e.g., habitual physical activity, tobacco use). Finally, we identified subtle and complex interactions between sociodemographic and occupational characteristics in these analyses. Even with a data set as large as the TAIHOD, it would be difficult to explore these interrelations in a multivariate setting. Therefore, in order to understand more fully the etiology of knee injury, future analyses should be targeted at specific demographic and occupational subgroups that appear to be at the highest risk.

The TAIHOD represents the linkage of several data bases originally compiled for administrative purposes. Although the data have been submitted to significant cleaning and editing for completeness, the original information was not collected or entered in a controlled manner. Hence, there are likely to be substantial inconsistencies in data quality and completeness across data entry sites and over time.

Regardless of internal problems with the data, TAIHOD represents a major resource for research in occupational health. These analyses demonstrate the usefulness of administrative data for analytical research. The complexity of the analyses we were able to carry out, and the rich variety of results obtained, point out the cost-effectiveness of using existing data for analytical epidemiology.

CHAPTER 4: SUMMARY, SYNTHESIS, AND CONCLUSION

INTRODUCTION

In separate pilot studies, we identified demographic and occupational risk factors for knee-related disability discharge from the U.S. Army (49, 58, 64). We recognized that, in the Army, disability status is determined after a series of medical and administrative events occur, and that the process of determining disability may take some time to complete. The risk factors for disability that we identified in the pilot work, therefore, represent a mixture of risk factors for the disability discharge and risk factors for the antecedent injury. In addition, there may be factors that influence the disability determination process and the awarding of benefits. These factors may be both inter-related and time-dependent.

Haddon's matrix is a tool used in the study of traumatic injuries. The technique is based on the premise that traumatic injuries occur as a result of a sequence of events that can be partitioned in time. Factors that occur during the pre-event phase influence the likelihood that an event will occur. Event phase factors influence the likelihood that an injury will follow from an event. Post-event phase factors relate to treatment; they impact on the likelihood of long-term or permanent disability following from the injury that has already occurred (10).

Consideration of Haddon's matrix suggested a new approach for the study of occupational disability: the use of multiple case-control analyses to identify risk factors for a series of dependent, inter-related outcomes. In the context of occupational knee-related disability, we defined the pre-event phase to comprise risk factors that operate prior to the initial knee injury. In the post-event phase, we identify risk factors for knee-related disability discharge from the Army. We aimed to increase our understanding of the natural history of disability by identifying and comparing pre-event and post-event factors. We hypothesized that some of the post-event risk factors for disability discharge relate to characteristics of the injury, some to the individual, and some to the more subjective components of the disability determination process.

The major objectives of this report were (1) to identify predictors of occupational musculoskeletal disability, with a focus on knee-related outcomes; and (2) to demonstrate that a series of related case-control comparisons can be used to identify differences in the determinants of causally related outcomes, specifically, knee injury and knee-related disability. An ancillary objective was to demonstrate that data collected for administrative purposes represent a cost-effective resource for analytical epidemiological studies.

KEY RESULTS

Based on pilot study results, we developed all models separately for men and for women (49, 58, 64). In this section, we present a qualitative summary and comparison of the results of the four main effect models (one model for each of two outcomes and two genders).

We emphasize here that it is most instructive to focus on differences between models, rather than similarities. This follows from the realization that if, in separate models, a factor is a predictor of both disability and injury, it is impossible to determine if the association with disability is solely due the factor's association with injury or if the effect is independent. Ideally, we would like to construct statistical models to identify differences between injuries and/or correlates of injuries that lead to disability discharge and those that do not lead to disability discharge. For this project, we used hospital records with a knee-related diagnosis or procedure code to identify knee injuries among individuals included in the data library (details are provided in Chapter 3). We found that 85% of those hospitalized for knee injury were eventually discharged for a knee-related disability. In the main TAIHOD, however, only 7% of those with knee-related hospitalization were discharged for knee-related disability, reflecting an over-representation of severe knee injuries in the data library as compared to the target population of all enlisted personnel in the Army. Owing to this over-representation of severe injury and to the resulting lack of overlap between groups of individuals hospitalized and disabled/hospitalized and not disabled, we were unable to implement the planned quantitative analyses. Instead, we present a qualitative comparison of models developed for each outcome, and present a modification of our original analysis plan.

Table 4.1 shows a qualitative summary of the key results of the main analyses. For female enlisted personnel, the final multivariable models predicting knee-related disability and injury contained nearly the same terms. Most point estimates in the two models demonstrated effects in the same direction, with approximately the same magnitude. There were two differences between the disability and injury models for the women. The first was the parameterization of marital status as a dichotomous variable (married vs. not married) in the disability model and as a three level variable (married and formerly married vs. single) in the injury model. However, in both the injury and disability models, non-married women were at higher risk than married women. The second difference between models was that duration of service was not a predictor of knee injury, but the odds of knee-related disability discharge increased with increasing length of service.

Table 4.1. Qualitative Summary of Results from the Final Main Effect Models

	Disability Model		Injury Model	
	Women	Men	Women	Men
Demographics				
Increasing age	Risk ⇑	Risk ⇑	Risk ⇑	--
Nonwhite race	⇓ vs. whites	⇓ vs. whites	⇓ vs. whites	⇓ vs. whites
Not married	⇑ vs. married	--	⇑ vs. married	--
HS education	--	--	--	⇑ vs. other
Occupational Factors				
Longer service	Risk ⇑	Risk ⇑	--	Risk ⇑
Higher pay grade	Risk ⇓	Risk ⇓	Risk ⇓	--
Admin. CMF	⇓ vs. others	⇑ vs. others	⇓ vs. others	⇓ vs. others
Work exposures				
Kneeling	--	Risk ⇑	--	--
Lifting	--	Risk ⇑	--	Risk ⇑
Standing	--	Risk ⇓	--	--
Demand rating	--	--	--	Risk ⇑

HS=high school diploma
Service=duration of service
Admin CMF=Support/administration Career Management Field (defined in Chapters 2 and 3)
Demand rating=Physical demand rating (defined in Chapter 3)

In contrast to the similarity of the injury and disability models for the women, there were several differences between the injury and disability models for the men. We found that the risk of knee-related disability discharge increased with increasing age, while age was not included in the final model for knee injury. We do not imply here that age is unimportant as a predictor of knee injury in men. Rather, in constructing the model for knee injury, we found that age, duration of service, and pay grade were highly correlated. The most stable multivariable model for knee injury in men resulted from the inclusion of duration of service; the other two factors had to be dropped from this model. As may be seen in Chapter 3, we also evaluated changes in the final injury model with the substitution of age and pay grade for duration of service.

Educational attainment at enlistment was an important determinant of the risk of knee injury, such that men who had completed either more or less than high school were at the lowest risk of knee injury. In contrast, educational attainment was not a predictor of knee-related disability discharge. Similarly, increasing pay grade was associated with a strong decrease in the risk of knee-related disability discharge, but pay grade was not a predictor of knee injury.

The most striking difference between the injury and disability models relates to the risks associated with various job categories (CMF). Men with jobs categorized as "Support/Administration" tended to be at higher risk of knee-related disability discharge than men whose jobs were otherwise categorized, whereas men in "Support/ Administration" CMF were at lower risk of knee injury compared to men in other job categories.

Limitations

The analyses reported here were based on samples drawn from the data library, which was constructed in order to facilitate the study of knee-related disability. The data library was intended to be used as a primary study base for analyses related to various occupational exposures and injury and disability outcomes among U.S. Army enlisted personnel (46). However, in a *post hoc* analysis, we determined that, relative to the target population of all enlisted personnel, the data library contains an over-representation of soldiers discharged for knee-related disability. Presumably, these are the most severe knee injury cases. In particular, 85% of soldiers with knee-related hospitalizations in the data library were eventually discharged for knee-related disability, whereas only 7% of those with knee-related hospital records in the TAIHOD were eventually discharged for a knee problem.

There are several likely consequences of this imbalance in the data library. First, the similarities between the final models for knee injury and knee-related disability may arise from the substantial overlap between the case series in these two samples. Second, estimated odds ratios for risk factors for knee injury that are also risk factors for knee disability may be biased away from 1.0. This follows from the fact that, relative to the source population, the injury cases are more likely, and the injury controls less likely, to possess traits predictive of disability discharge. Third, estimated odds ratios for risk factors for knee injury that are not also determinants of disability are probably unbiased, though we lack power to detect such factors due to the small number of injury cases that did not progress to knee-related disability in this data set. Finally, as mentioned above, we lack power to conduct an analysis of risk factors for knee-related disability discharge conditional on knee-related hospitalization, due to the lack of overlap between the hospitalized and disabled/hospitalized and not disabled groups that would be required for such an analysis.

Our results indicated a general lack of association between injury or disability and occupational exposures. In these analyses, we used ecological level measures for job exposures, mapping from PMOS to CMF, physical demands, and job tasks. The use of ecological measures undoubtedly led to substantial exposure misclassification, since there is latitude in the assignment of tasks within PMOS. The mapping was based on Army procedure manuals (19), and occurred without regard to case or control status. Since the mapping from PMOS to work exposures was performed in a consistent manner for all records included in the data library, and without consideration of the eventual outcome, the resulting exposure misclassification is nondifferential and results in a bias towards the null (53). Therefore, the effects associated with CMF and job tasks that we reported are most likely underestimates of the true effects. In the many instances where we report null effects, there may be true differences in risk associated with work exposures or job titles.

Pay grade and duration of service, the only occupational characteristics that did show a consistent relation with injury and disability, are individual level measures. These parameters may well be surrogates for other factors, such as age or job

exposures. If pay grade and/or duration of service are standing in for job exposures, these might also vary with age, seniority and experience.

Other data problems result from the administrative origins of these files. Because the databases were not developed as research tools, we found that some potentially valuable fields were coded with too many values to be helpful; others were coded with too little variability. In addition, the data were collected, coded and entered by hundreds of individuals in hundreds of locations around the world. As far as we are aware, there is little standardization of data coding or entry procedures, and little or no quality assurance. Therefore, there may be undetectable errors in the information analyzed.

Apart from characteristics of the information included, we encountered some problems with sparse data, especially when cross-classifying the population by many characteristics to evaluate effect modification or to identify special subgroups at risk. In spite of these problems, we were able to identify occupational and sociodemographic determinants of knee injury and knee-related disability discharge from the U.S. Army.

Revised Analysis Plan

We have recently been awarded funding from the National Institute of Occupational Safety and Health to continue this work. The major goal of the next phase of this research will be to quantitatively evaluate the differences between risk factors for knee injury and disability. Because of the high degree of correlation in the data library between the occurrence of knee-related hospitalization and discharge from the Army for knee problems, a quantitative comparison of risk factors for these two outcomes requires that we a draw new data series from the TAIHOD. Cases will be defined as soldiers with both a knee-related hospitalization and a knee-related disability discharge. Controls will be incidence-density sampled from among the pool of individuals with a knee-related hospitalization who have not been discharged for knee-related disability as of the case disability discharge date. This sampling plan will yield a data set that represents the target population, and will enable either a case-control (logistic regression) analysis or an analysis of time to disability conditional on knee injury (survival analysis).

Regardless of type of analysis to be carried out, the risk factors to be considered include the following:

Demographic characteristics:

- Gender
- Race
- Age
- Marital status
- Educational attainment at enlistment
- Educational attainment at first hospitalization

Occupational characteristics:

- Duration of service
- Pay grade
- CMF
- Physical demand rating
- Job tasks (kneeling, lifting, walking, sitting, standing, etc.)

Health factors:

- Number of hospitalizations
- Number of knee-related hospitalizations
- Number of hospitalizations for the same knee-related diagnosis or condition
- Characteristics of each knee-related hospitalization (tissue type, chronicity, surgical status)

USE OF RELATED CASE-CONTROL STUDIES TO ANSWER TIME-DEPENDENT QUESTIONS

Time dependent questions are most typically addressed in cohort studies. However, when the outcome is rare, or when one wishes to evaluate the effects of several exposures on a single outcome, then cohort studies are both logistically and statistically inefficient. It can be shown that relative risks calculated from a cohort analysis are mathematically identical to the odds ratios calculated from case-control analysis when the sampling fractions are known (see Chapter 1). The approach used here, of carrying out related case-control analyses embedded in the same population, is highly efficient, both logistically and statistically, and yields the same results as would be obtained had we carried out a cohort study.

In spite of the substantial overlap between the case series for the two research questions, we were able to identify differences between the models for injury and disability. The differences in the sets of risk factors we identified implies that we have successfully partitioned time into pre-event (risk factors for injury) and post-event (risk factors for disability) phases. Furthermore, the difference between the two final models suggests that the technique of using separate case-control analyses to address related research questions is a viable option for identifying differences in risks for dependent outcomes. We therefore propose that this technique may prove a useful addition to the collection of epidemiology research methods.

USE OF ADMINISTRATIVE DATA FOR RESEARCH PURPOSES

Since the data included in TAIHOD were not subjected to quality assurance during collection and entry, we encountered problems related to data quality. There were several different kinds of data problems. One type of problem includes those issues that arise during data entry, such as missing data and the possibility of entry errors. Other issues are associated with the content of the database, and related to the administrative purposes for which the data were collected. For example, we found that, in some instances, too many possible codes were included in the data files, leading to too great a level of specificity (e.g., there are thousands of job codes used by the Army).

In other instances, the lack of specificity in codes hampered our ability to accurately classify individuals with respect to either exposures or outcome (e.g., the VASRD codes group reasons for disability discharge into broad categories). We also identified some information lacking from the TAIHOD that would have been useful (e.g., Which knee is affected? Is it the first occurrence of a problem in that knee? Were there any outpatient encounters related to that knee problem?).

Several strengths of the research presented in this report should be mentioned at this juncture. Unlike civilian populations, the U.S. Army offers a structured social and work environment. It is reasonable to assume that medical care is equally available to all Army personnel, thus removing variability in access to care as an alternative explanation for observed differences in reported injury rates. We did not face the problem of ensuring an initially disease-free cohort that is often encountered in cohort and nested case-control studies, since enlistment in the U.S. Army entails passing a physical examination. Reasons for being found ineligible for enlistment include internal derangement of the knee, instability of the knee, and history of knee surgery or injury (18). Therefore, injuries detected during a tour of active duty are more likely to have occurred during that tour of duty, and not prior to enlistment in the Army.

CONCLUSION

The fact that we were able to identify occupational risk factors for knee injury suggests that, eventually, the risk of knee injury and disability among Army personnel may be modifiable by implementing changes to work tasks, training, equipment or job assignments. The interaction between occupational and demographic characteristics that we identified suggests that there may be subgroups within certain jobs that are more susceptible to injury or disability than others. If so, then changes to equipment, training or job assignments may prove fruitful in the effort to reduce the occurrence of knee injury and related disability. Furthermore, in spite of data problems outlined above, we were able to identify risk factors for each of the outcomes under consideration, and to identify differences in the sets of predictors for the two outcomes. That we were able to develop models suggests that the TAIHOD, and other administrative databases, represent a useful resource that ought to be exploited for research. However, because of the problems outlined above, and because a major aim of this project was to explore the utility of the TAIHOD for analytical epidemiological studies, the results reported herein should be considered preliminary.

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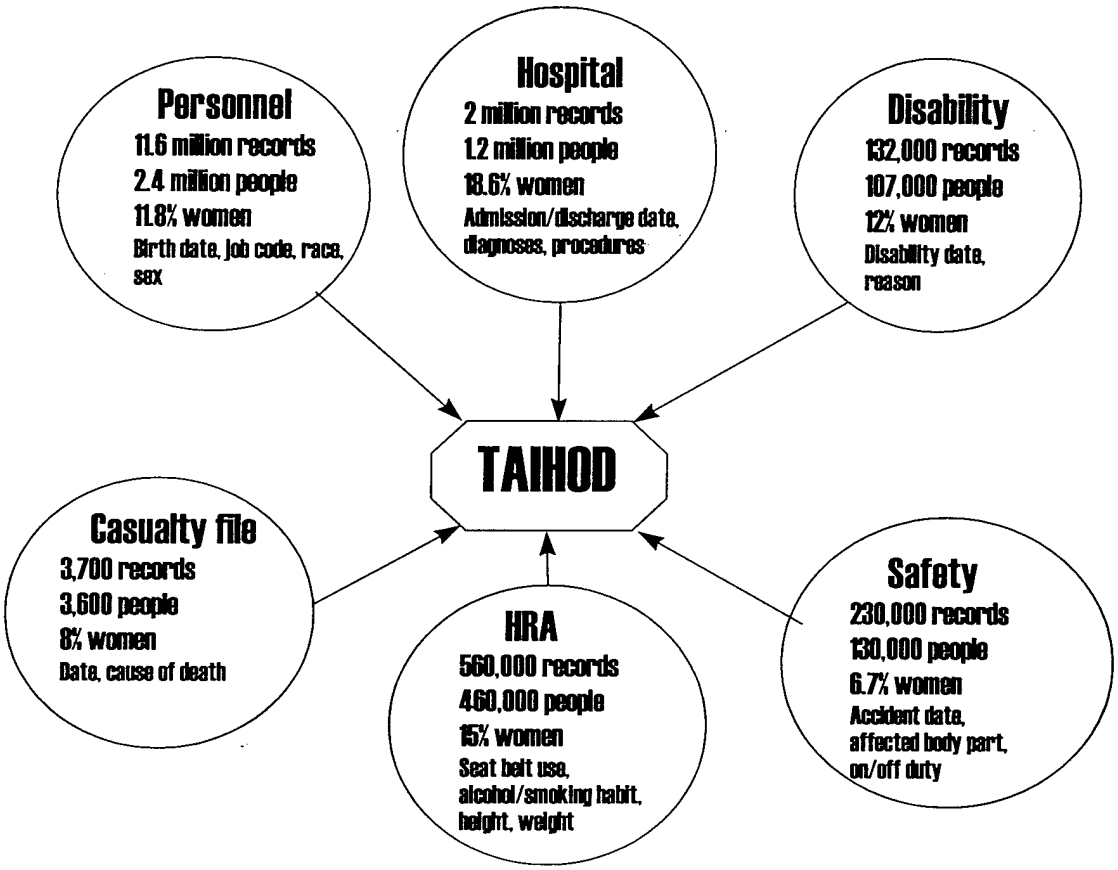
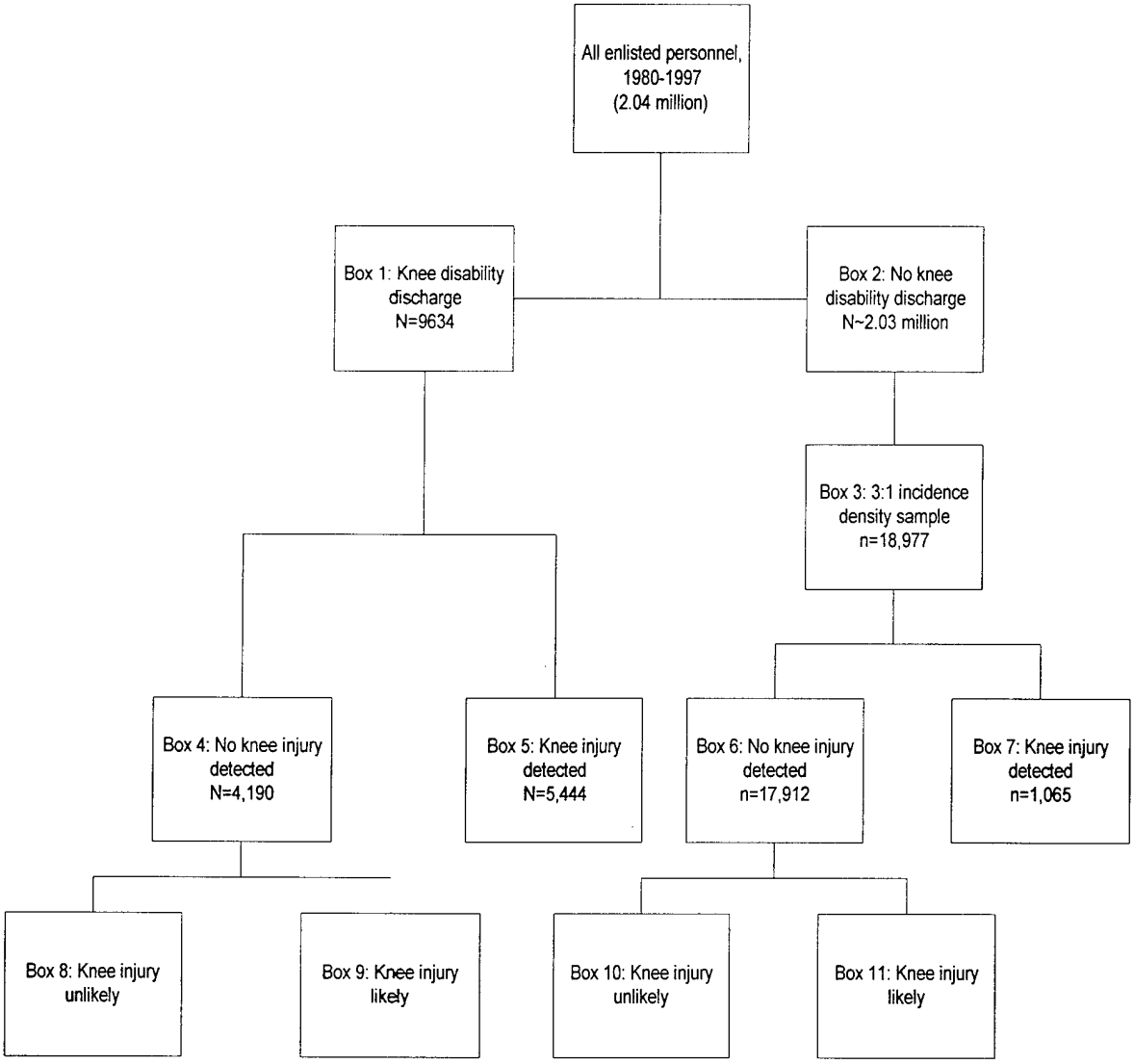
APPENDIX A: THE TOTAL ARMY INJURY AND HEALTH OUTCOMES DATABASE (TAIHOD)



APPENDIX B: CONSTRUCTION OF DATA LIBRARY AND ANALYTIC SUBSETS



APPENDIX C: EVALUATION OF KNEE-RELATED HOSPITALIZATIONS IN THE DATA LIBRARY

The hospital data file contains 41,127 records for the period from January 1, 1980, through December 31, 1997. Of these hospitalizations, 42.8% are associated with soldiers who eventually were discharged for knee-related disability (data not shown). An average of 2.54 admissions was recorded per person among individuals ever hospitalized. Ever hospitalized soldiers eventually discharged for knee-related disability had an average of 2.38 hospitalizations per person, while ever-hospitalized solders not discharged for knee-related disability had an average of 2.67 hospitalizations per person (p=0.0001, Table C.1).

Table C.1. Mean Numbers of Admissions and Diagnoses among All Soldiers with Hospital Records Included in the Data Library*

			Disabled		
	Variable	All	Yes	No	p**
Admissions/ID	ADMCNT				
Mean number		2.54	2.38	2.67	0.0001
Range		1-34	1-20	1-34	
Diagnoses/admission (any type)	DX_N				
Mean number		1.91	1.92	1.89	0.04
Range		1-8			
Diagnoses/ID (any type)	DX_NN				
Mean number		4.57	7.21	8.56	0.0001
Range		1-91			
Procedures/admission (any type)	PROC_N				
Mean number		5.06	5.57	4.69	0.0001
Range		0-8			
Procedures/ID (any type)	PROC_NN				
Mean number		12.14	20.77	19.67	0.0001
Range		0-162			
Knee diagnoses/admission	KDX_N				
Mean number		0.38	0.79	0.08	0.0001
Range		0-7			
Knee diagnoses/ID	KDX_NN				
Mean number		0.91	2.51	0.34	0.0001
Range		0-22			
Knee procedures/admission	KPROC_N				
Mean number		0.18	0.36	0.04	0.0001
Range		0-6			
Knee procedures/ID	KPROC_NN				
Mean number		0.43	0.36	0.04	0.0001
Range		0-14			

* D:\ARMY\DATA LIBRARY\SAS DATA\HOSP01.SD2

** P-value from t-test comparing means for ever-hospitalized soldiers eventually discharged for knee-related disability and ever-hospitalized soldiers not discharged for knee-related disability.

ALL DIAGNOSES

Up to 8 diagnoses and up to 8 procedures may be recorded for each hospitalization. An average of 1.91 diagnoses of any type is recorded for each hospitalization. Hospital records for soldiers eventually discharged for knee-related disability have, on average, 1.92 diagnoses/admission, while records for ever-

hospitalized soldiers without knee disability discharge have, on average, 1.89 diagnoses/admission (p=0.04). When data are aggregated over ID, the number of diagnoses per person ever hospitalized ranges from 1-91, with an average of 4.57. Ever-hospitalized soldiers discharged for knee-related disability had an average of 8.56 diagnoses per person, while ever-hospitalized soldiers without knee-related disability discharge had an average of 7.21 diagnoses per person (p=0.0001, Table C.1.)

ALL PROCEDURES

The average number of procedures of any type was 5.06 per admission. Records for ever-hospitalized soldiers with eventual knee disability discharge had an average of 5.57 procedures, while records for ever-hospitalized soldiers without knee disability discharge had an average of 4.69 procedures (p=0.0001). Aggregating records over ID shows an average of 12.14 procedures per person recorded for all hospitalized individuals, with the number of procedures per person ranging from 0-162. Ever-hospitalized soldiers discharged for knee-related disability had an average of 20.77 procedures recorded per person, while ever-hospitalized soldiers not discharged for knee-related disability had an average of 19.67 procedures recorded per person (p=0.0001, Table C.1).

KNEE-RELATED ADMISSIONS

If knee-related admissions are defined as records containing at least one knee-related diagnosis or procedure code recorded in any available field, then 10,443/41,127 (25.4%) records in the hospital file are knee-related. Of these, 5,222 admissions were surgical, having at least one knee-related procedure recorded in any of 8 available procedure fields, and 5,221 were non-surgical knee-admissions. Surgical knee admissions represent 12.7% of all admissions and 50% of all knee-related admissions. A total of 610 hospital records indicate that at least one knee-related procedure was performed in the absence of any knee-related diagnosis. The appendix lists all ICD-9-CM procedure and diagnosis codes considered knee-related (data not shown).

Tables C.2 and C.3 describe the distribution of knee-related diagnoses and procedures across available diagnosis and procedure fields in the data file. Table C.3 shows 8,685/41,127 (21.1%) hospital records have a knee-related primary diagnosis. More than half, 5,002/8,685 (57.6%), have no other knee-related diagnosis. Of all records with a primary knee-related diagnosis, 3,508/8,685 (40.4%) also have a knee-related diagnosis in the second diagnosis field, N=1402 (16.1%) have a knee diagnosis in the third diagnosis field, N=487 (5.6%) have a knee-related diagnosis in the fourth diagnosis field. Table C.3 shows that 3,485 records in the hospital file have a knee-related primary procedure. Of these, N=2,028 have no other knee procedures recorded. 1,059/3,485 (30.4%) have a knee procedure in the second field, 514 have a knee procedure in the third field. There are 622 hospital records that have at least one knee related procedure code, but no knee-related diagnosis.

Table C.2. Number and Percentage of Records with a Knee Diagnosis in Each Position

		Diagnosis position							
	Diagnosis	1	2	3	4	5	6	7	8
(%)	1	5015[a]	(40.5)	(16.1)	(5.6)	(1.4)	(0.4)	(0.1)	(0.0)
n		8717	3527	1407	490	118	31	11	4
	2	(82.7)	588[a]	(32.5)	(11.5)	(2.8)	(0.7)	(0.3)	(0.0)
		3527	4246	1386	490	119	31	11	1
	3	(81.2)	(80.0)	154[a]	(29.4)	(6.9)	(1.7)	(0.8)	(0.0)
		1407	1386	1733	510	119	29	13	1
	4	(73.4)	(73.4)	(76.3)	72[a]	(18.9)	(4.6)	(1.9)	(0.4)
		490	490	510	668	126	31	13	3
	5	(61.8)	(62.3)	(62.3)	(66.0)	27[a]	(18.3)	(3.7)	(0.5)
		118	119	119	126	191	35	7	1
	6	(38.8)	(38.8)	(36.3)	(38.8)	(43.8)	28[a]	(12.5)	(6.3)
		31	31	29	31	35	80	10	5
	7	(26.2)	(26.2)	(31.0)	(31.0)	(16.7)	(23.8)	17[a]	(14.3)
		11	11	13	13	7	10	42	6
	8	(19.0)	(4.8)	(4.8)	(14.3)	(4.8)	(23.8)	(28.6)	11[a]
		4	1	1	3	1	5	6	21

a. Number with knee diagnosis in that position, only

Table C.3. Number and Percentage of Records with a Knee Procedure in Each Position

		Procedure position							
	Procedure	1	2	3	4	5	6	7	8
(%)	1	2028[a]	(30.4)	(14.7)	(4.0)	(1.0)	(0.5)	(0.1)	(0.0)
n		3485	1059	514	141	36	5	2	1
	2	(43.4)	1104[a]	(16.7)	(1.4)	(0.5)	(0.2)	(0)	(0)
		1059	2442	409	33	11	4	1	1
	3	(50.0)	(39.7)	250[a]	(11.2)	(3.5)	(0.9)	(0.1)	(0.1)
		514	409	1029	115	36	9	1	1
	4	(49.8)	(41.7)	(40.6)	34[a]	(15.2)	(3.2)	(1.4)	(1.1)
		141	118	115	283	43	9	4	3
	5	(40.4)	(37.1)	(40.4)	(48.3)	8[a]	(14.6)	(4.5)	(2.2)
		36	33	36	43	89	13	4	2
	6	(17.9)	(39.3)	(32.1)	(32.1)	(46.4)	5[a]	(17.9)	(0.7)
		5	11	9	9	13	28	5	3
	7	(15.4)	(30.8)	(7.7)	(30.8)	(30.8)	(38.5)	2[a]	(23.1)
		2	4	1	4	4	5	13	3
	8	(12.5)	(12.5	(12.5)	(37.5)	(25.0)	(37.5)	(37.5)	1[a]
		1	1	1	3	2	3	3	8

a. Number with knee procedure in that position, only

KNEE-RELATED DIAGNOSES

The average number of knee-related diagnoses per hospital admission is 0.38. Ever-hospitalized soldiers discharged for knee-related disability had an average of 0.79 knee-related diagnoses, while hospitalized soldiers without knee-related disability had an average of 0.08 knee diagnoses per admission (p=0.0001, Table C.1). The average number of knee-related diagnoses per person ever hospitalized was 0.91, with an average of 2.51 knee diagnoses recorded per hospitalized person discharged for knee-related disability and 0.34 knee diagnoses recorded per hospitalized person without knee-related disability (p=0.0001, Table C.1).

KNEE-RELATED PROCEDURES

An average of 0.18 knee procedures was recorded per admission. Hospitalized soldiers discharged for knee-related disability had an average of 0.36 knee procedures per admission, while hospitalized soldiers without knee-related disability had an average of 0.04 knee procedures per admission (p=0.0001). The average number of knee procedures per person ever hospitalized was 0.43, with an average of 0.36 knee procedures per person for hospitalized soldiers discharged for knee-related disability, and 0.04 for hospitalized soldiers not discharged for knee-related disability (p=0.0001, Table C.1).

CHRONICITY AND TISSUE TYPE

Knee-related diagnoses may be categorized along dimensions of chronicity and of tissue type. Most diagnoses are of mixed acute/chronic origin, with proportions in this category ranging from 38% to 67% of diagnoses recorded (Table C.4). The proportion of purely acute conditions among knee-related diagnoses ranges from 12.4% (second diagnosis field) to 35.7% of diagnoses (7th diagnosis field), and the proportion of purely chronic conditions ranges from 19% (primary diagnosis field) to 33% of diagnoses (8th diagnosis field). Most diagnoses involved soft tissue rather than hard tissue. The proportion of soft tissue diagnoses ranged from 24% (8th diagnosis field) to 68% (primary diagnosis field).

Table C.4. Categorization of Knee-Related Diagnoses as Acute/Chronic/Mixed and as Involving Soft or Hard Tissue, Based on Diagnoses, Only

	Diagnosis position (number of knee-related diagnoses recorded)							
	1 (N=8717)	2 (N=4246)	3 (N=1733)	4 (N=668)	5 (N=191)	6 (N=80)	7 (N=42)	8 (N=21)
Chronicity								
Acute (%)	1262 (14.5)	529 (12.4)	262 (15.1)	121 (18.1)	35 (18.3)	24 (30.0)	15 (35.7)	6 (28.6)
Chronic (%)	1638 (18.8)	1118 (26.2)	432 (24.9)	202 (30.2)	53 (27.27)	23 (28.8)	10 (23.8)	7 (33.3)
Mixed (%)	5817 (66.7)	2617 (61.4)	1039 (60.0)	345 (51.6)	103 (53.9)	33 (41.3)	17 (40.5)	8 (38.1)
Tissue type								
Soft (%)	5924 (68.0)	3070 (72.0)	1249 (72.1)	452 (67.7)	118 (61.8)	47 (58.8)	17 (40.5)	5 (23.8)
Hard (%)	2793 (32.0)	1194 (28.0)	484 (27.9)	216 (32.3)	73 (38.2)	33 (41.3)	25 (59.5)	16 (76.2)

Each admission may also be categorized according to chronicity and tissue type. If all knee-related diagnoses recorded for a given admission were either acute or chronic, then the admission may be considered acute or chronic, respectively. If any one diagnosis could be categorized as mixed acute/chronic, or if there were a mixture of acute and chronic diagnoses recorded, then the admission may be considered mixed acute/chronic. Overall, 13% of admissions were for acute conditions, 17% were for chronic conditions, and 71% of admissions were for mixed acute/chronic problems (Table C.5). Using a similar categorization method, 60% of admissions were for soft

tissue injuries, 32% were for hard tissue injuries and 8% were for mixed soft and hard tissue problems (Table C.5). Categorization of each admission according to tissue type depends mainly on diagnoses. However, for the N=610 admissions where a knee-related procedure was recorded in the absence of a knee-related diagnosis, tissue type was based on the type of procedure performed.

Table C.5. Categorization of Knee-Related Hospitalizations as Acute/Chronic/Mixed and as Involving Soft or Hard Tissue Based on Diagnoses and Procedures

	Number	Percent
Chronicity		
Acute[a] (%)	1,232	12.5
Chronic[a] (%)	1,653	16.8
Mixed[b] (%)	6,948	70.7
Total[d]	9,833	100
Tissue type		
Soft[a] (%)	6,249	59.8
Hard[a] (%)	3,310	31.7
Mixed[c] (%)	884	8.5
Total[d]	10,443	100

a. All knee-related diagnoses for a given admission.
b. Either a mixture of acute and chronic diagnoses or at least one mixed acute/chronic diagnosis recorded for a given admission.
c. Mixture of diagnoses involving soft and hard tissues.
d. Chronicity based on diagnoses only; tissue type based on diagnoses, only, if available. For N=610 records with knee-related procedures but no diagnoses, tissue type based on procedure.

Table C.6. Definition of Knee-Related Hospitalizations Using ICD-9-CM Procedure and Diagnosis Codes. Use the most specific codes under each category.

ICD-9-CM code	Definition	Chronicity Acute – A Chronic – C Both –B	Tissue type Soft –S Bony – B
355.2	Other lesion of the femoral nerve	(B)more likely A[a]	S
355.3	Lesion of lateral popliteal nerve	(B) more likely A[a]	S
355.4	Lesion of medial popliteal nerve	(B) more likely A[a]	S
712.16	Chondrocalcinosis due to dicalcium phosphate crystals	C	S
712.26	Chondrocalcinosis due to pyrophosphate crystals	C	S
712.36	Chondrocalcinosis, unspecified	C	S
712.86	Other specified crystal arthopathies of the lower limb, knee	C	S
712.96	Unspecified crystal arthropathy of the lower limb, knee	C	S
715.16	Osteoarthritis, localized, primary, of the lower limb, knee	C	B
715.26	Osteoarthritis, localized, secondary, of the lower limb, knee		
715.36	Osteoarthritis, localized, not specified whether primary or secondary, of the lower limb, knee	C	B
715.96	Osteoarthritis, not specified whether generalized or localized, of the lower limb, knee	C	B
716.06	Kaschin-Beck disease, endemic polyarthritis of lower limb, knee	C	B
716.16	Traumatic arthropathy of lower limb, knee	A	S
716.26	Allergic arthritis of lower limb, knee	A	S
716.36	Climacteric arthritis of lower limb, knee	C	S
716.46	Transient arthropathy of lower limb, knee	B	S
716.56	Unspecified polyarthropathy or polyarthritis of lower limb, knee	C	S
716.66	Unspecified monoarthritis of lower limb, knee; coxitis	C	S
716.86	Other specified arthropathy of lower limb, knee	C	S
716.96	Arthopathy, unspecified, of lower limb, knee	C	S
717	Internal derangement of knee (old)	C	S
717.0	Old bucket handle tear of medial meniscus	C	S
717.1	Derangement of anterior horn of medial meniscus	B	S
717.2	Derangement of posterior horn of medial meniscus	B	S
717.3	Other and unspecified derangement of medial meniscus	B	S
717.4	Derangement of lateral meniscus	B	S
717.5	Derangement of meniscus, not elsewhere classified	B	S
717.6	Loose body in knee	B	S (occas. B)[c]
717.7	Chondromalacia of patella	B	S
717.8	Other internal derangement of knee	B	S
717.9	Unspecified internal derangement of knee	B	S
718.26	Pathological dislocation of knee	B	S
718.36	Recurrent dislocation knee	C	S
718.45	Contracture of pelvic region and thigh	C	S
718.46	Contracture of lower limb, knee	C	S
718.56	Ankylosis of lower limb, knee	C	S (rarely B)[c]
718.85	Instability of pelvic region and thigh	C	S
718.86	Instability of knee	(B frequently) A[a]	S

ICD-9-CM code	Definition	Chronicity Acute – A Chronic – C Both –B	Tissue type Soft –S Bony – B
719.06	Effusion of knee joint	(B) normally A[a]	S
719.16	Hemarthrosis of knee	A	S
719.26	Villondular synovitis, knee	C	S
719.36	Palindromic rheumatism, knee	C	S
719.46	Pain in joint, arthralgia of knee	C	S
719.56	Stiffness of knee joint, NEC	C	S
719.66	Other symptoms referable to knee joint, crepitus	C	S
719.86	Other specified disorders of joint, calcification, fistula (knee)	C	S
719.96	Unspecified disorder of joint, knee	B	S
726.6	Enthesopathy of the knee (burstitis)	(B normally) C[b]	S
727.51	Synovial cyst of popliteal space (Baker's cyst)	C	S
727.65	Quadriceps tendon rupture	A	S
727.66	Rupture of patellar tendon	A	S
727.86	Other disorders of synovium, tendon and bursa (lower limb, knee)	C (occasionally A on C)[b]	S
727.89	Abscess of bursa or tendon	A	S
727.9	Unspecified disorder of synovium, tendon and bursa	(B normally) C[b]	S
728.12	Traumatic myostitis ossificans	A	S
729	Other disorders of soft tissues		
729.0	Rheumatism, unspecified, and fibrositis	C	S
729.1	Myalgia amd myositis, unspecified	(B normally) C[b]	S
729.2	Neuralgia, neuritis and radiculitis, unspecified	C	S
729.3	Panniculitis, unspecified	C	S
729.4	Fasciitis, unspecified	B	S
729.5	Pain in limb	B	S
729.6	Residual foreign body in soft tissue	C	S
729.8	Other musculoskeletal symptoms referable to limbs	C	S
729.9	Other and unspecified disorders of soft tissue	B	S
730	Osteomyelitits, periostitis, and other infections involving bone	(B normally) C[b]	B
730.06	Acute osteomyelitis, lower leg	A	B
730.16	Chronic osteomyelitis, lower leg	C	B
730.26	Unspecified osteomyelitis, lower leg	C	B
730.36	Periostitis without mention of osteomyelitis, lower leg	C	B
730.76	Osteopathy resulting from poliomyelitis, lower leg	C	B
730.86	Other infections involving bone in diseases classfied elsewhere, lower leg	B	B
730.96	Unspecified infection of bone, lower leg.	B	B
732.4	Juvenile osteochondrosis of lower extremity, excluding foot; Osgood-Schlatters syndrome	C	B
732.7	Osteochondritis dissecans	C (or A on C)[b]	B
733.10	Stress fracture	A (becomes C)[a]	B
733.81	Malunion of fracture	C	B
733.82	Nonunion of fracture/pseudoarthrosis	C	B
733.9	Other and unspecified disorders of bone and cartilage	B	B
736.4	Acquired genu valgum or varum	C	B
736.5	Acquired genu recurvatum	C	B

ICD-9-CM code	Definition	Chronicity Acute – A Chronic – C Both –B	Tissue type Soft –S Bony – B
736.6	Other acquired deformities of the knee NOS	C	B
821.01	Closed fracture of femoral shaft	A	B
821.11	Open fracture of femoral shaft	A	B
821.21	Fracture of femoral condyle	A	B
821.3	Open fracture of lower end of femur	A	B
821.31	Open fracture of femoral condyle	A	B
822	Fracture of patella	A	B
823.0	Fracture of proximal tibia, closed	A	B
823.1	Fracture of proximal tibia, open	A	B
836	Dislocation of knee	A	B
843.8	Sprain/strain of hip/thigh	B	B
844	Sprains of the knee and leg	B	B
897.0	Amputation below the knee	B	B
897.2	Amputation above the knee	B	B
905.6	Late effect of dislocation (no body part specified?)	C	S
905.7	Late effect of sprain or strain (no body part specified?)	C	S
905.8	Late effect of tendon injury (no body part specified?)	C	S
924.00	Contusion: thigh	A	S
924.11	Contusion: knee	A	S
928.11	Crushing injury of knee	A	S (code bony as fracture elsewhere)[c]

a. Code as acute
b. Code as chronic
c. Code as soft tissue injury

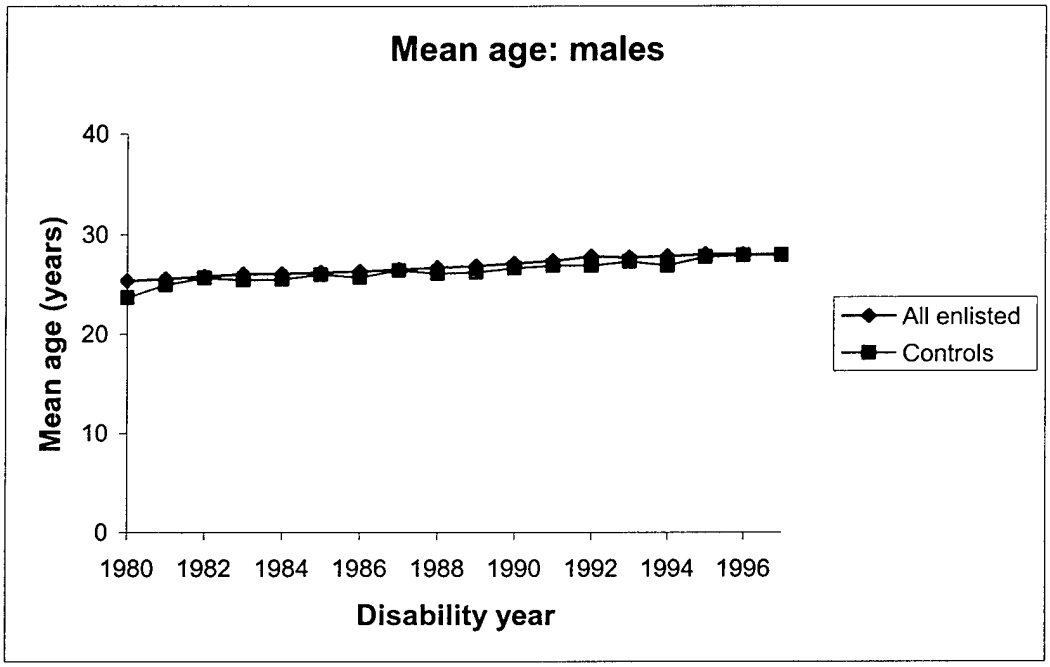
Table C.7. Procedure Codes in the Range 77-81, "Operations on the Musculoskeletal System"

Procedure Code	Description	Tissue type
77	Incision, excision and division of other bones	
77.0	Sequestrectomy	
77.05	of femur	B
77.06	of patella	B
77.07	of tibia and fibula	B
77.1	Other incision of bone without division	
77.15	of femur	B
77.16	of patella	B
77.17	of tibia and fibula	B
77.2	Wedge osteotomy	
77.25	of femur	B
77.26	of patella	B
77.27	of tibia and fibula	B
77.3	Other division of bone	
77.35	of femur	B
77.36	of patella	B
77.37	of tibia and fibula	B
77.4	Biopsy of bone	
77.45	of femur	B
77.46	of patella	B
77.47	of tibia and fibula	B
77.6	Local excision of lesion or tissue of bone	
77.65	of femur	B
77.66	of patella	B
77.67	of tibia and fibula	B
77.7	Excision of bone for graft	
77.75	of femur	B
77.76	of patella	B
77.77	of tibia and fibula	B
77.8	Other partial ostectomy	
77.85	of femur	B
77.86	of patella	B
77.87	of tibia and fibula	B
77.9	Total ostectomy	
77.95	of femur	B
77.96	of patella	B
77.97	of tibia and fibula	B
78.0	Bone graft	
78.05	of femur	B
78.06	of patella	B
78.07	of tibia and fibula	B
78.1	Periosteal suture	
78.15	of femur	B
78.16	of patella	B
78.17	of tibia and fibula	B
78.4	Other repair or plastic operations on bone	
78.45	of femur	B
78.46	of patella	B
78.47	of tibia and fibula	B
78.5	Internal fixation of bone without fracture reduction	
78.55	of femur	B
78.56	of patella	B
78.57	of tibia and fibula	B
78.6	Removal of internal fixation device	

Procedure Code	Description	Tissue type
78.65	of femur	B
78.66	of patella	B
78.67	of tibia and fibula	B
78.7	Osteoclasis	
78.75	of femur	B
78.76	of patella	B
78.77	of tibia and fibula	B
78.8	Diagnostic procedures on bone, NEC	
78.85	of femur	B
78.86	of patella	B
78.87	of tibia and fibula	B
78.9	Insertion of bone growth stimulator	
78.95	of femur	B
78.96	of patella	B
78.97	of tibia and fibula	B
79.76	Closed reduction of dislocation of knee	B
79.86	Open reduction of dislocation of knee	B
80.06	Arthrotomy for removal of prosthesis (knee)	M
80.16	Other arthrotomy (knee)	M
80.26	Arthroscopy (knee)	M
80.36	Biopsy of joint structure (knee)	M
80.46	Division of joint capsule, ligament or cartilage (knee)	S
81.22	Arthrodesis of knee	B
81.41	Total knee replacement	B
81.42	5-in-1 knee repair	B
81.43	Triad knee repair	B
81.44	Patellar stabilization	B
81.45	Other repair of cruciate ligaments	S
81.46	Other repair of collateral ligaments	S
81.47	Other knee repair	M
84.10	Lower limb amputation, NOS	M
84.15	Other amputation below knee	M
84.16	Disarticulation of knee	M
84.17	Amputation above knee	M
84.27	Lower leg or ankle reattachment	M
84.40	Implantation or fitting of prosthetic limb device, NOS	M
84.45	Fitting of prosthesis above the knee	M
84.46	Fitting of prosthesis below the knee	M
84.47	Fitting of prosthesis of leg, NOS	M

APPENDIX D: DEMOGRAPHIC COMPARISONS

Figure D.1. Mean Age of All Enlisted Personnel and Data Library Controls, By Year, 1980-1996



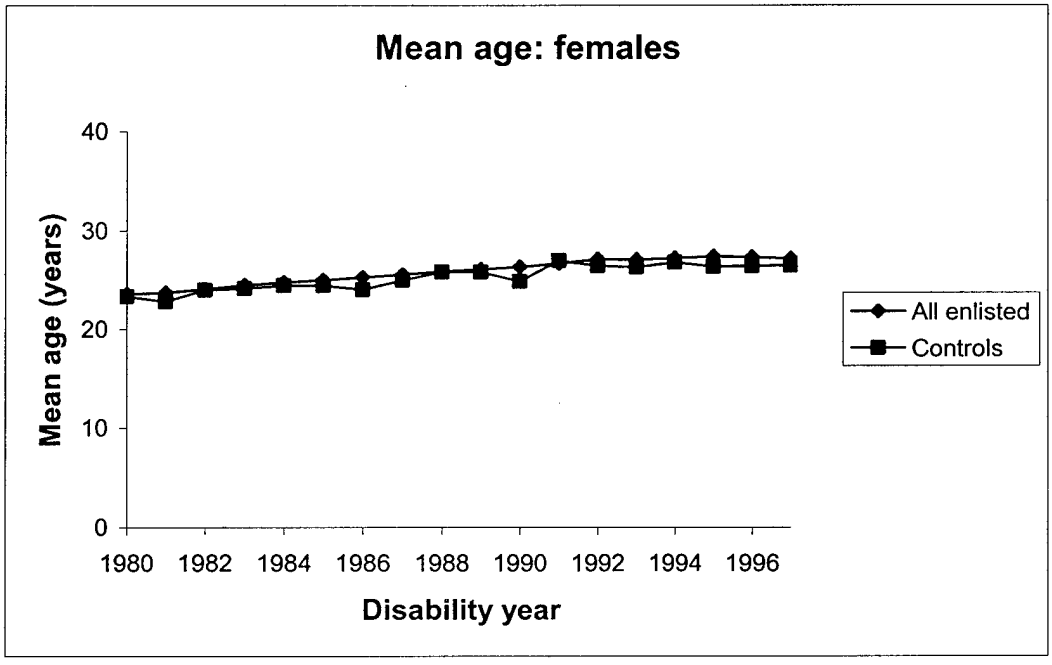
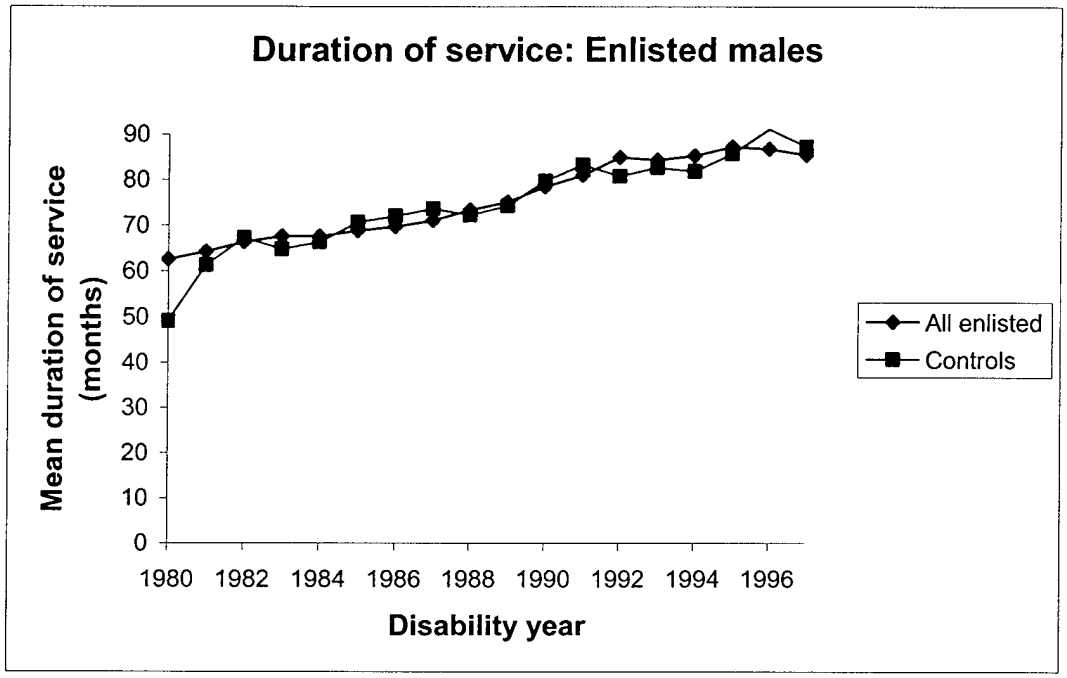


Figure D.2. Mean Duration of Service of All Enlisted Personnel and Data Library Controls, By Year, 1980-1996



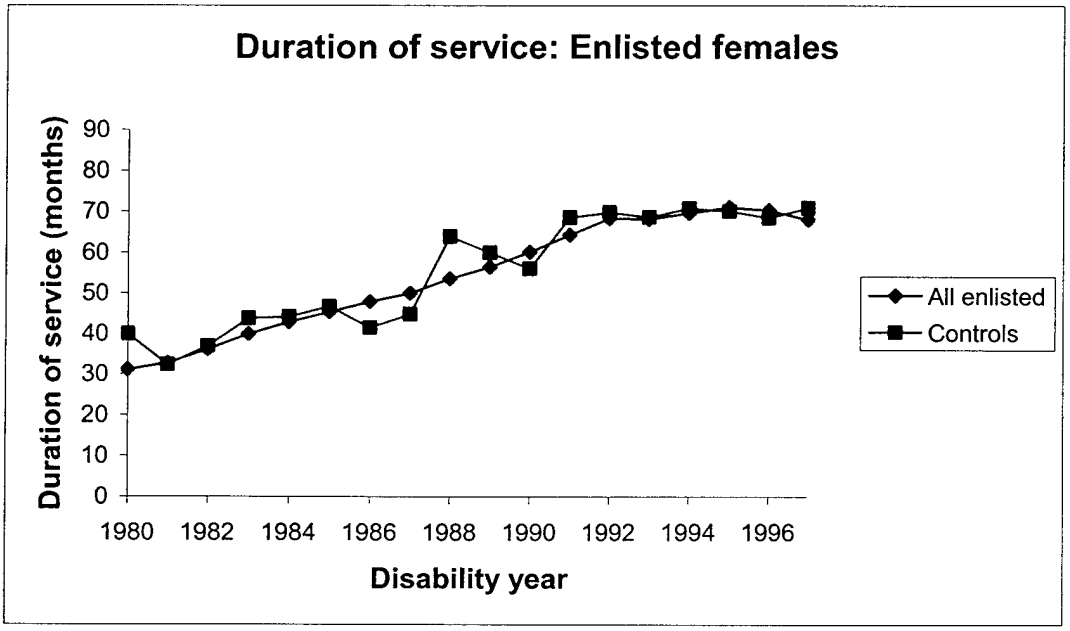


Figure D.3. Distribution of Race/Ethnicity among All Female Enlisted Personnel and Data Library Controls, By Year, 1980-1996

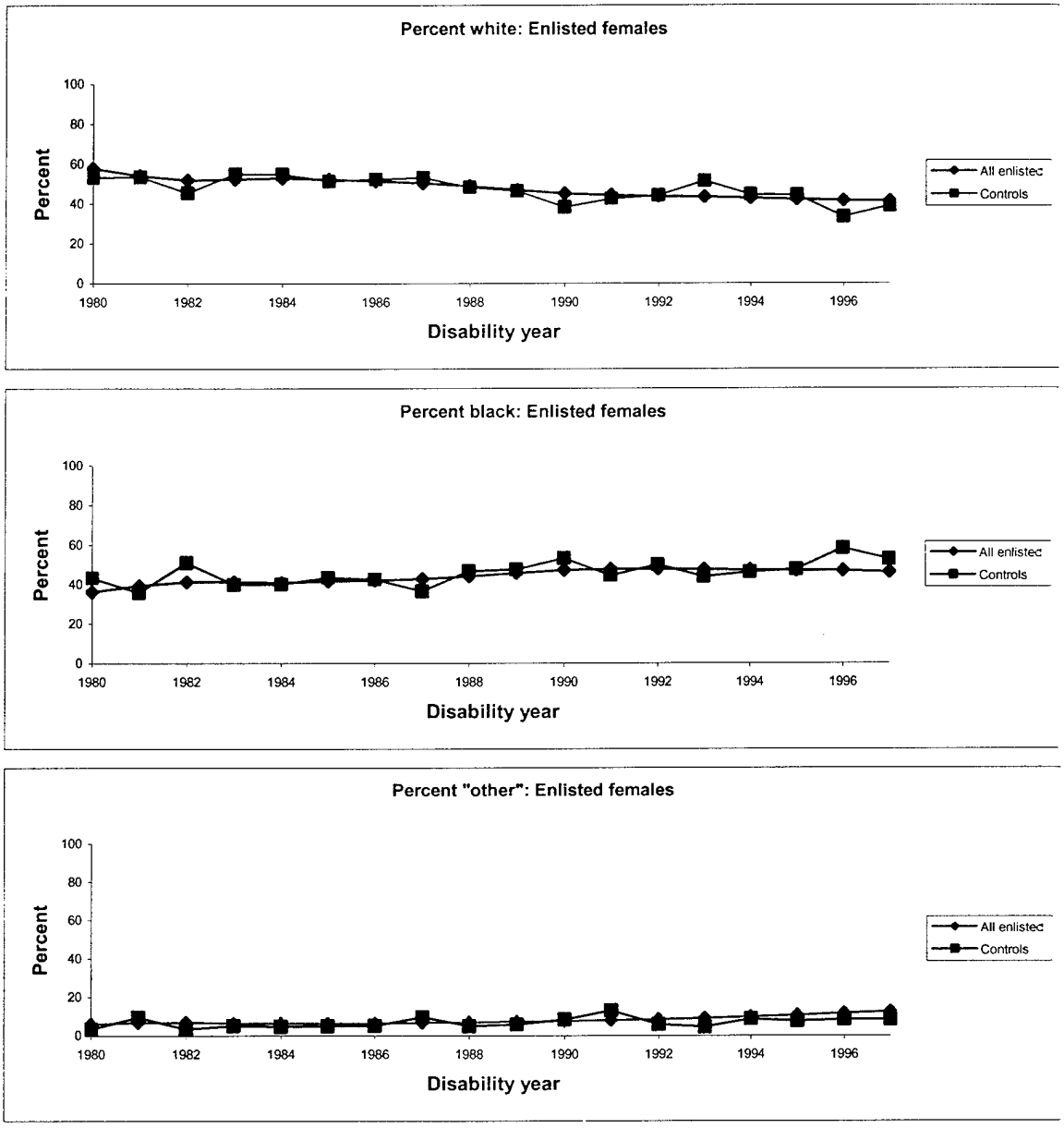
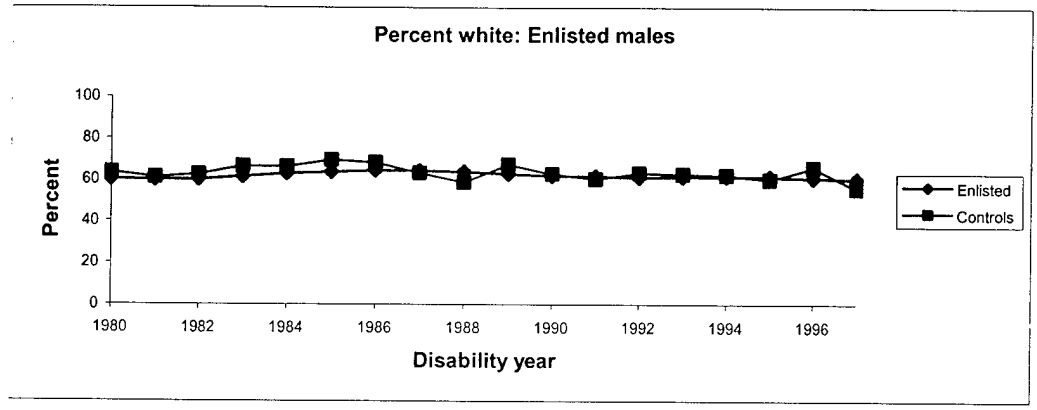
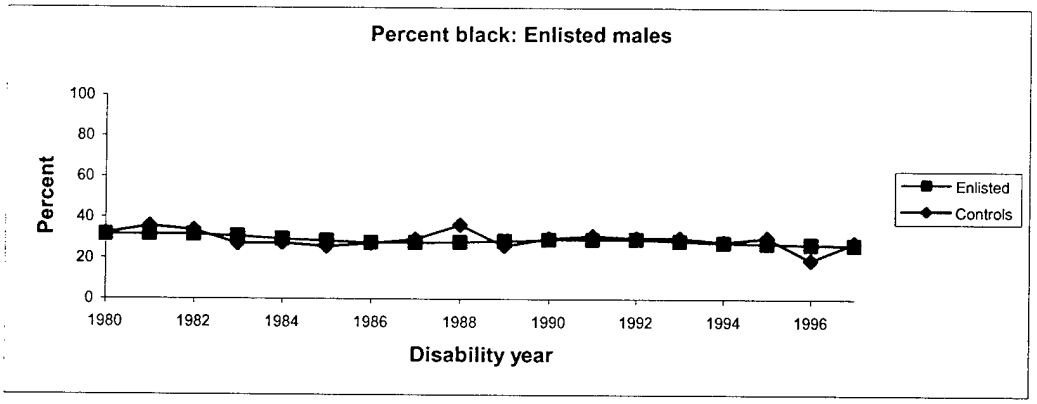


Figure D.4. Distribution of Race/Ethnicity among All Male Enlisted Personnel and Data Library Controls, By Year, 1980-1996





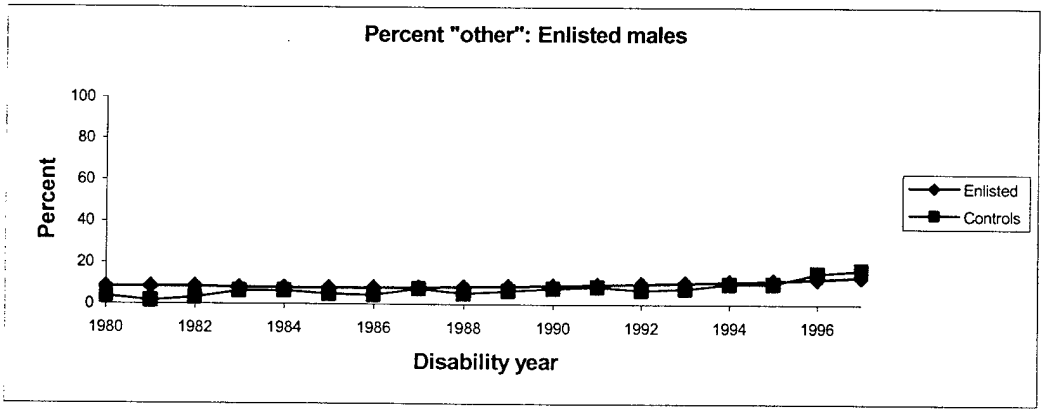
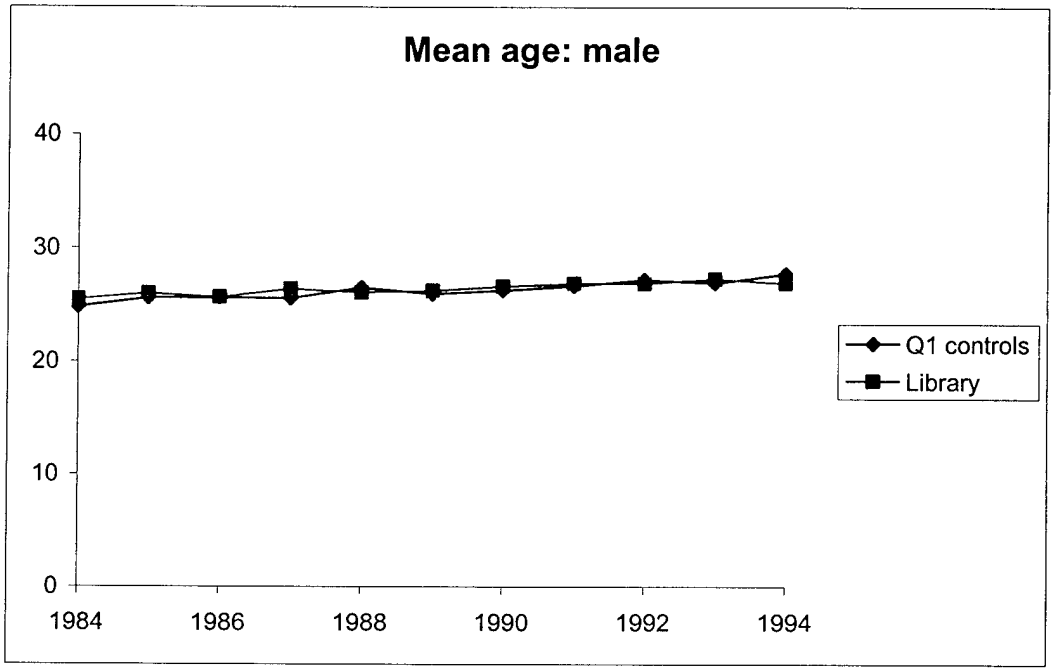


Figure D.5. Mean Age of Data Library Controls and Controls From Research Question 1 Analysis Set, By Year, 1984-1994



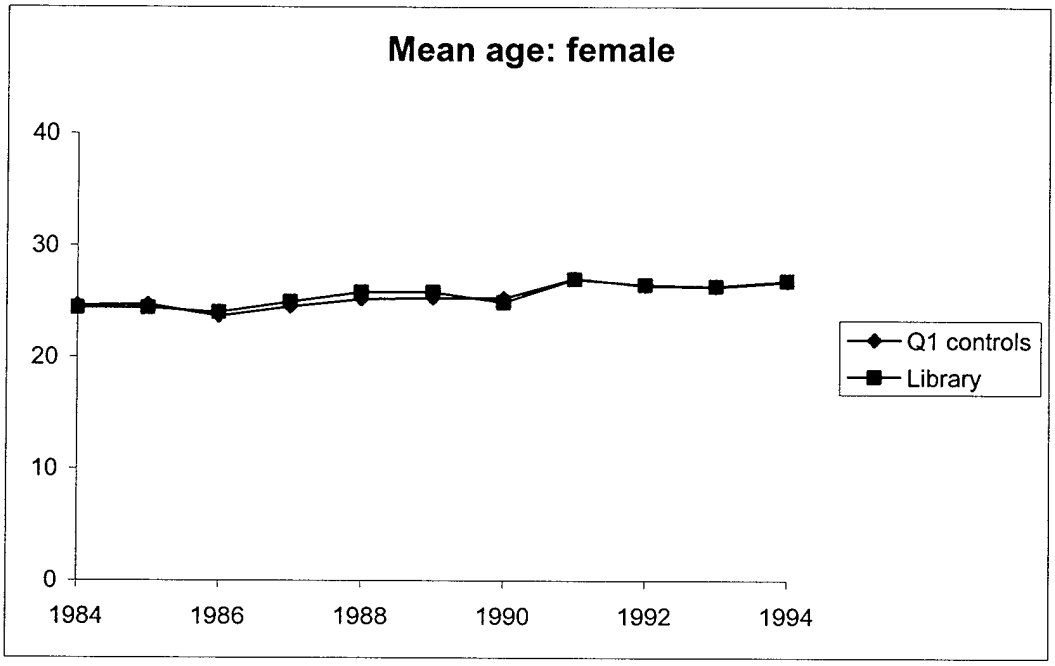
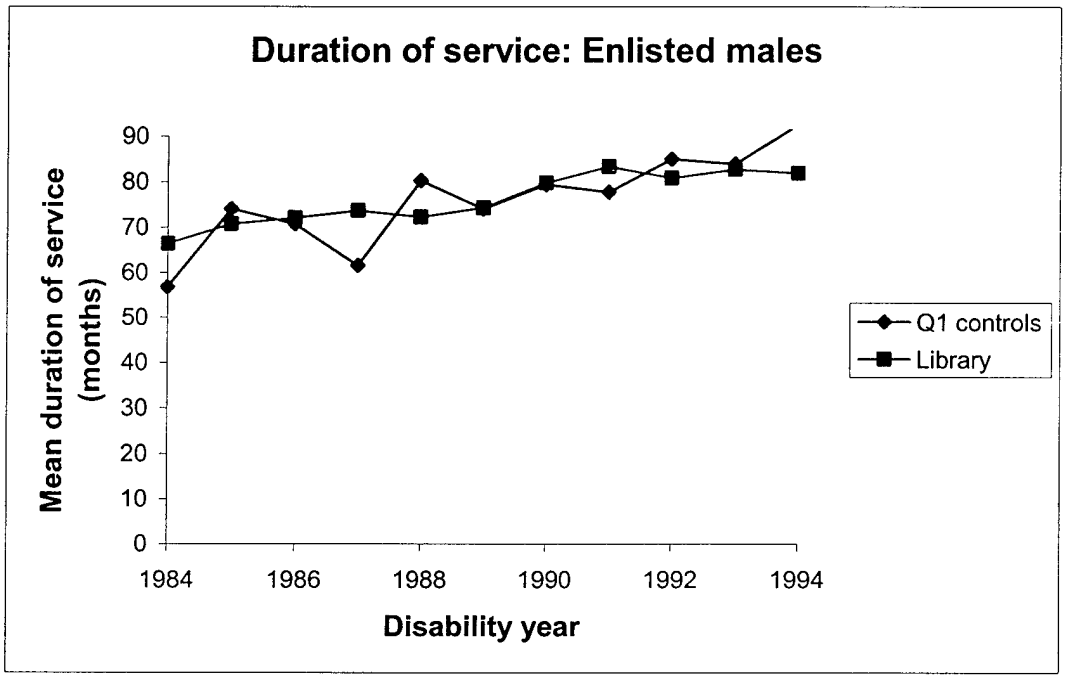


Figure D.6. Mean Duration of Service of Data Library Controls and Controls from Question 1 Analysis Set, By Year, 1984-1994



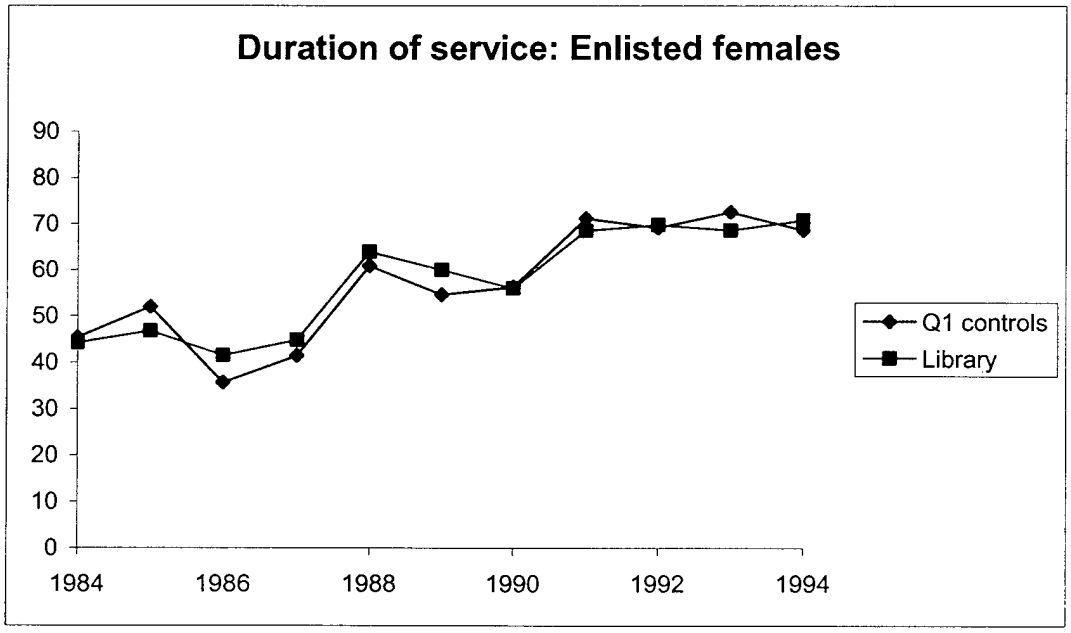
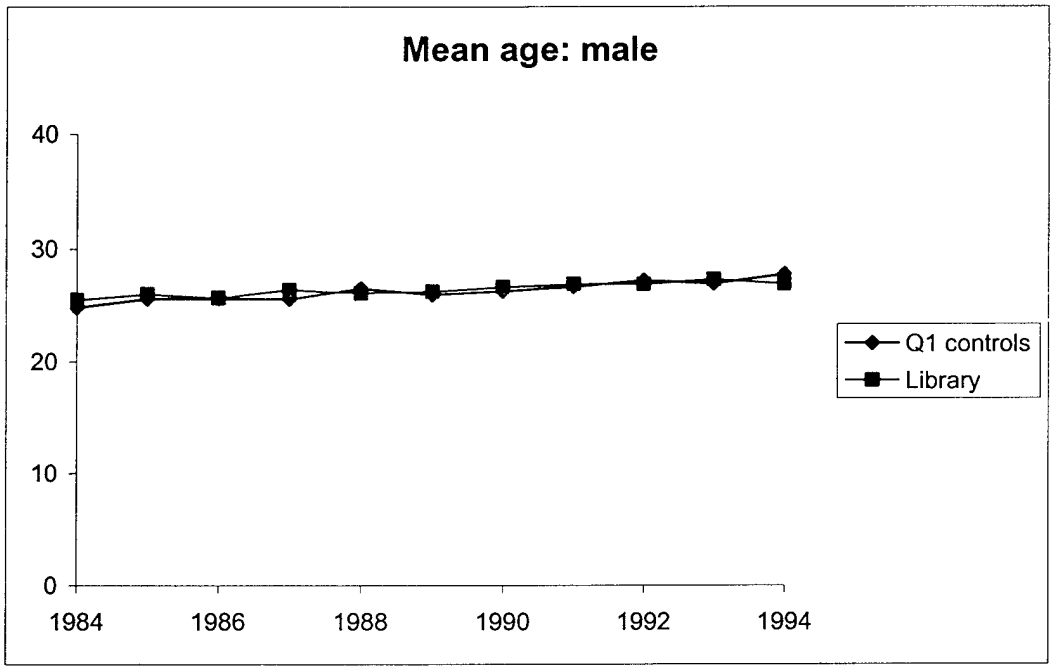


Figure D.5. Mean Age of Data Library Controls and Controls From Research Question 1 Analysis Set, By Year, 1984-1994



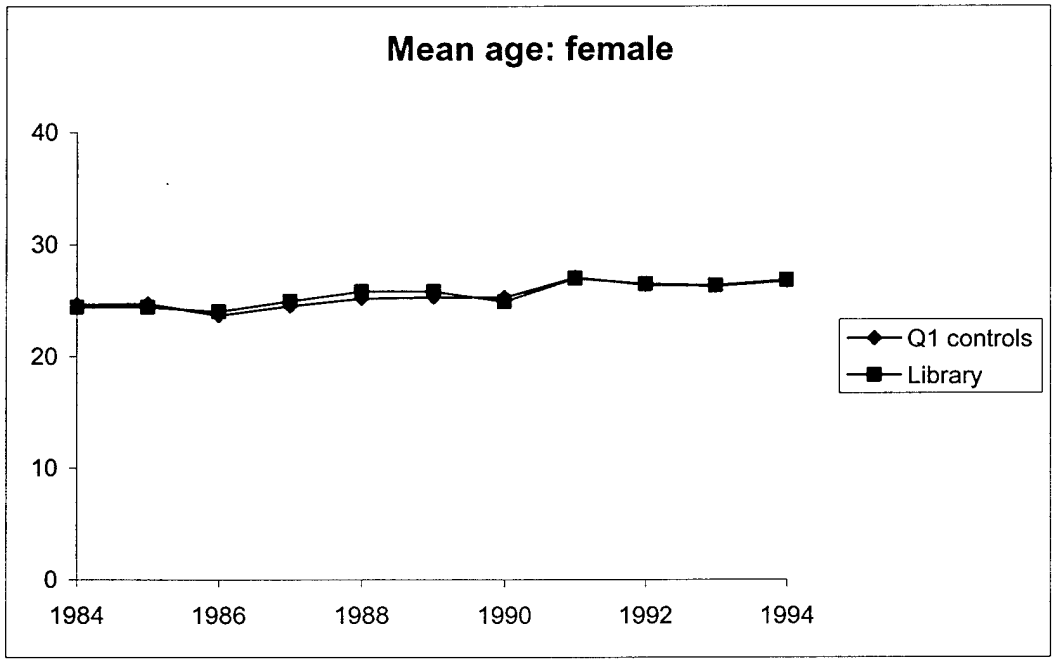
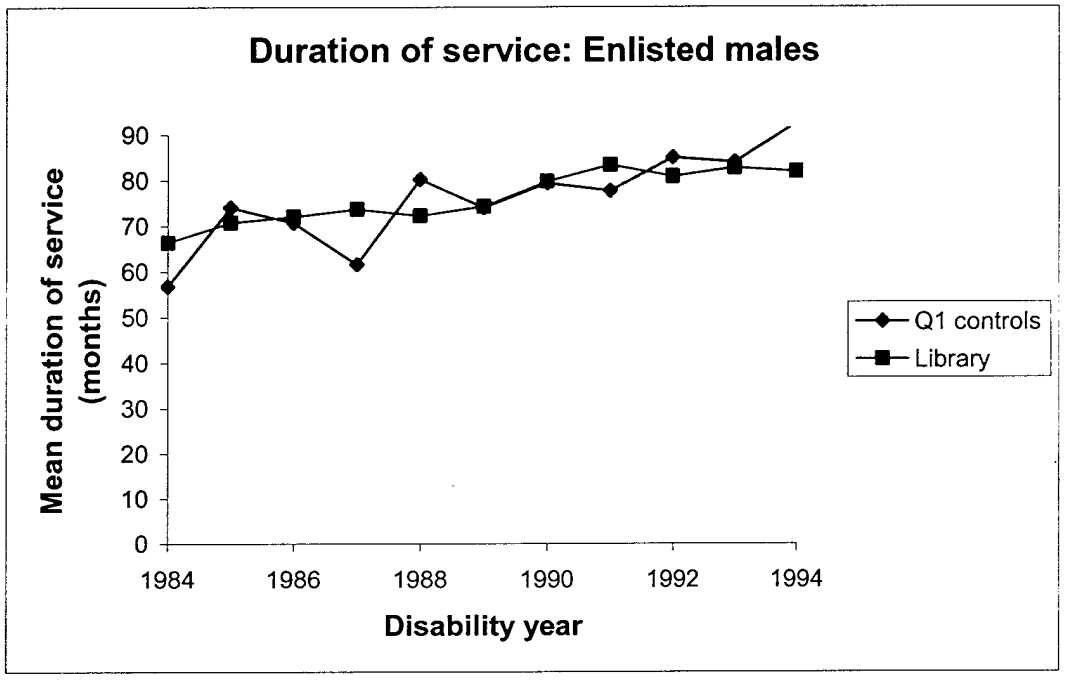


Figure D.6. Mean Duration of Service of Data Library Controls and Controls from Question 1 Analysis Set, By Year, 1984-1994



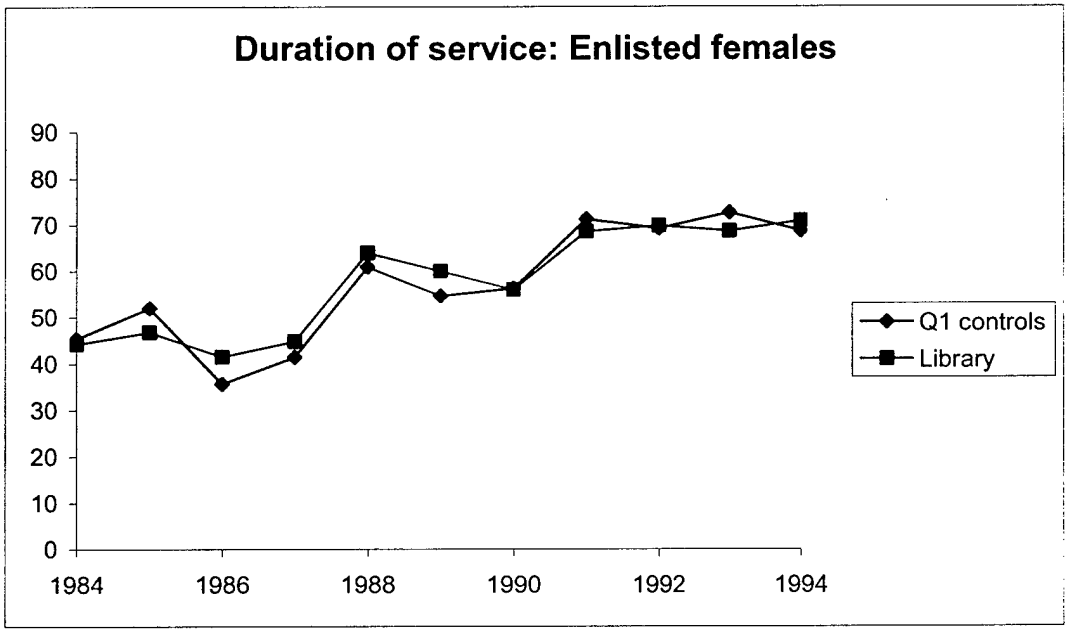


Figure D.7. Distribution of Race/Ethnicity among Female Data Library Controls and Controls from Question 1 Analysis Set, By Year, 1984-1994

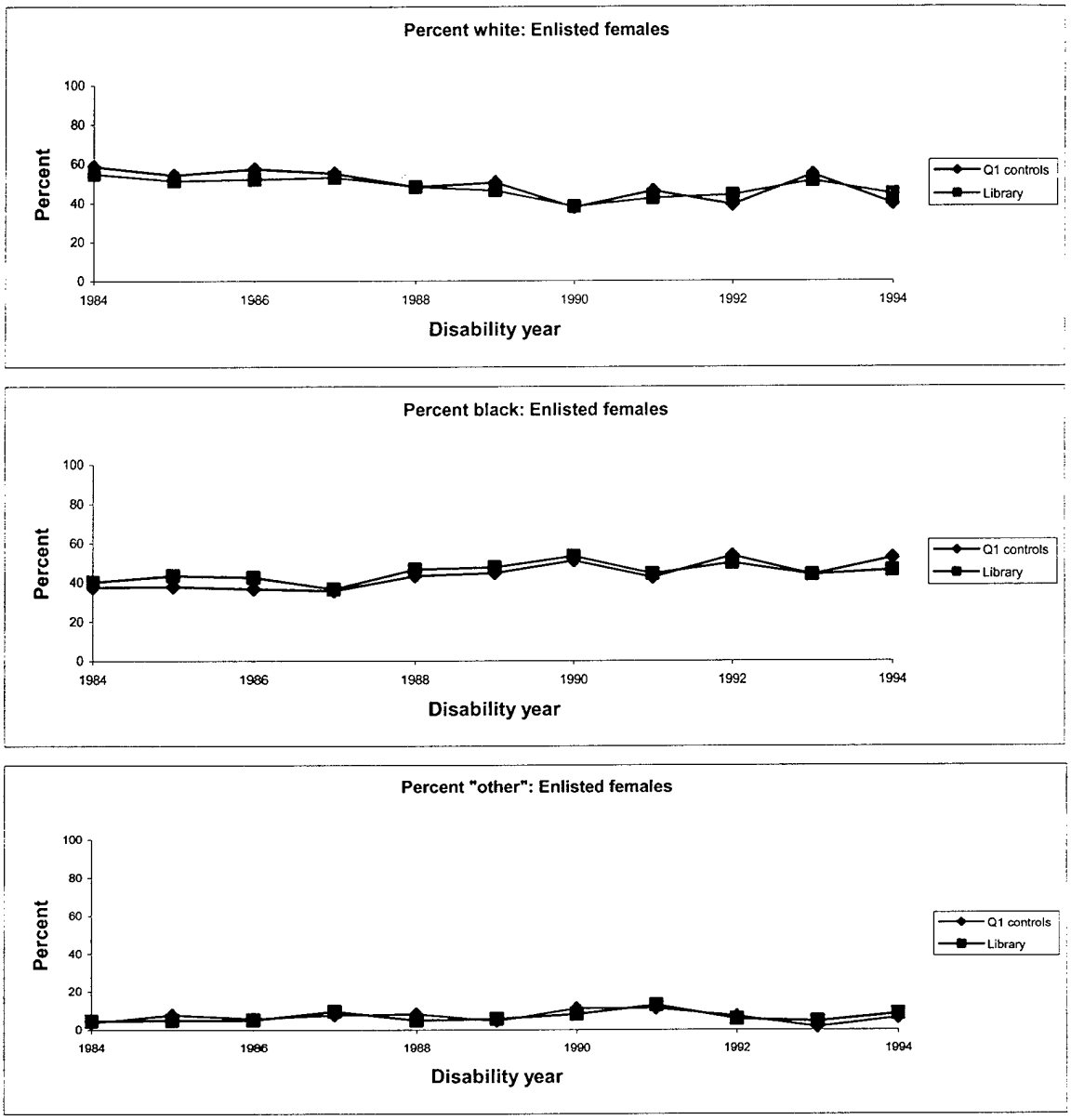
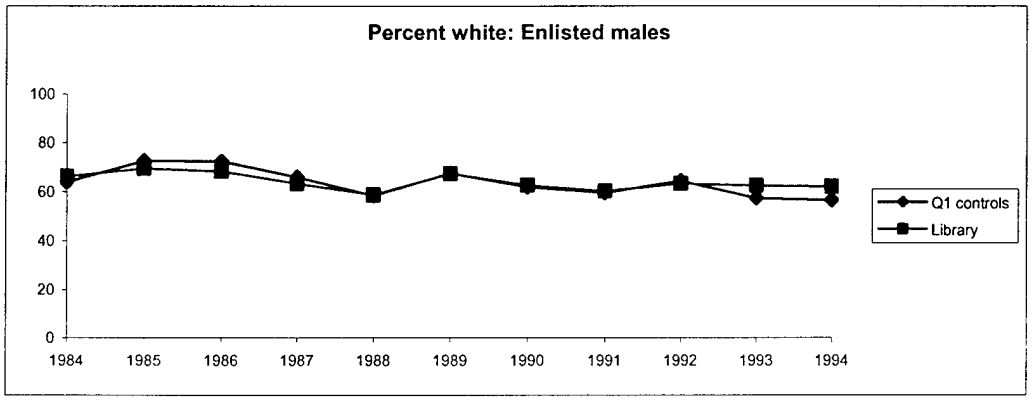
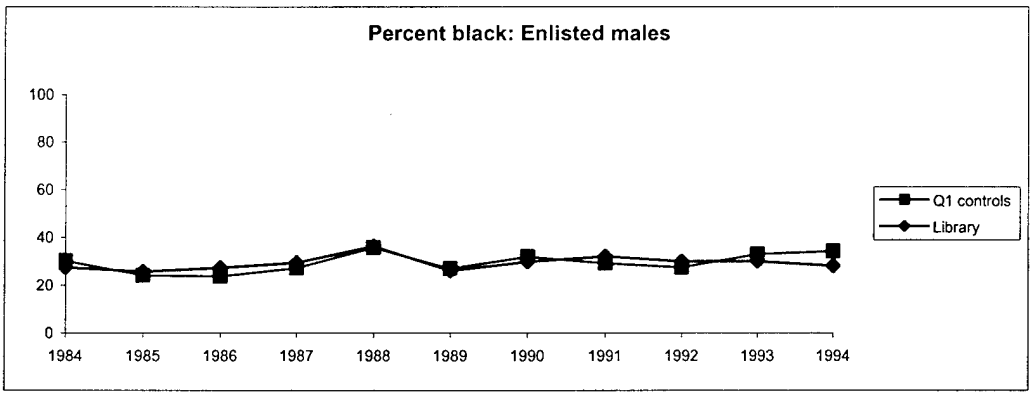


Figure D.8. Distribution of Race/Ethnicity among Male Data Library Controls and Controls from Question 1 Analysis Set, By Year, 1984-1994





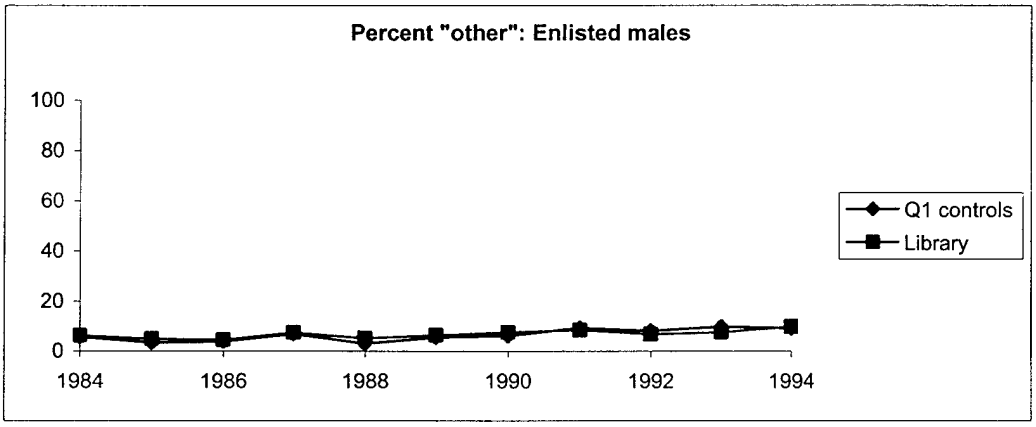
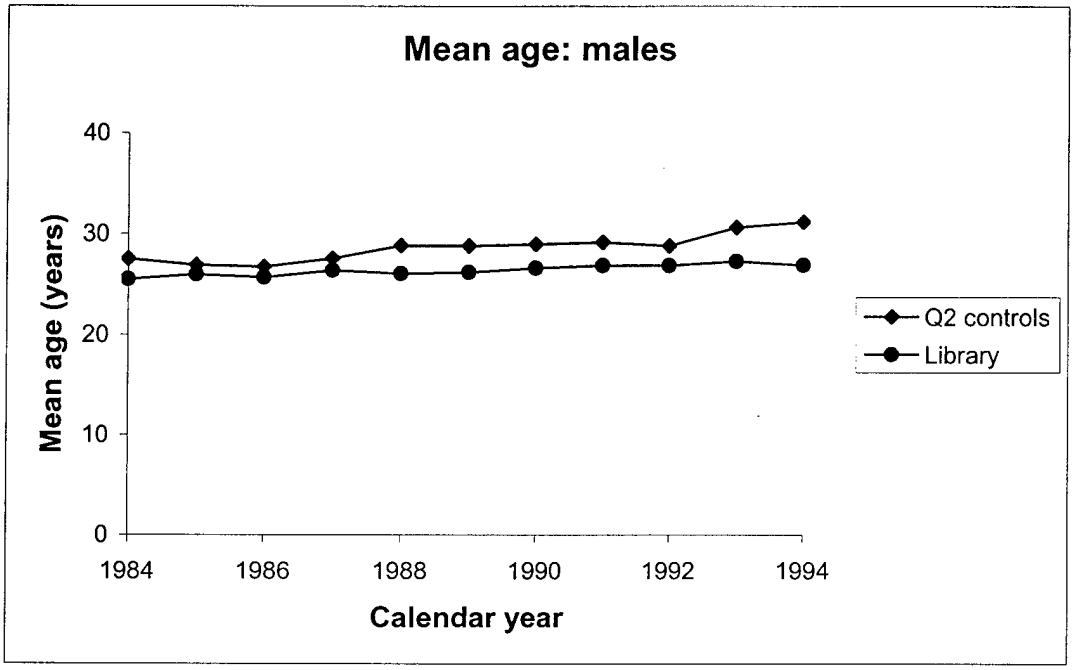


Figure D.9. Mean Age of Data Library Controls and Controls from Research Question 2 Analysis Set, By Year, 1984-1994



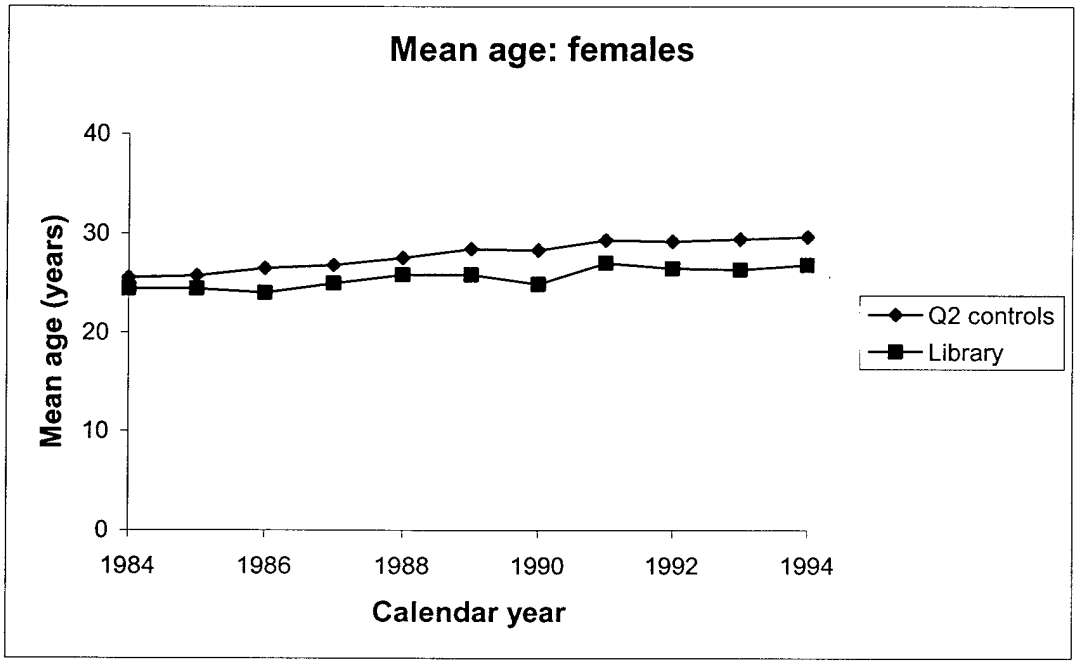
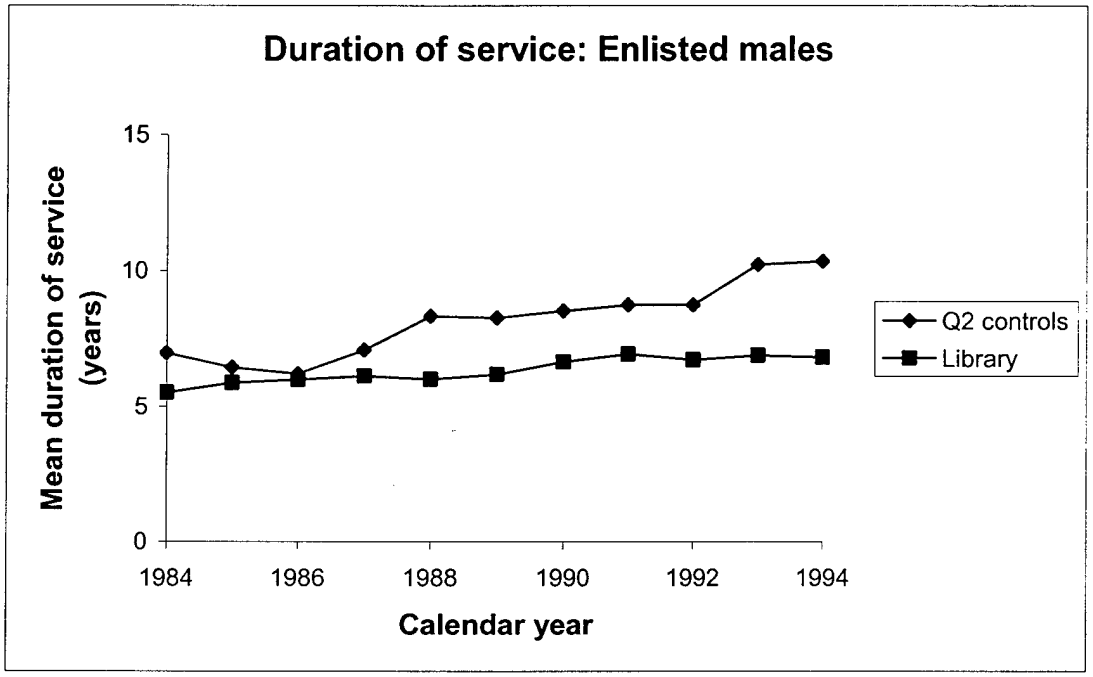


Figure D.10. Mean Duration of Service of Data Library Controls and Controls from Question 2 Analysis Set, By Year, 1984-1994



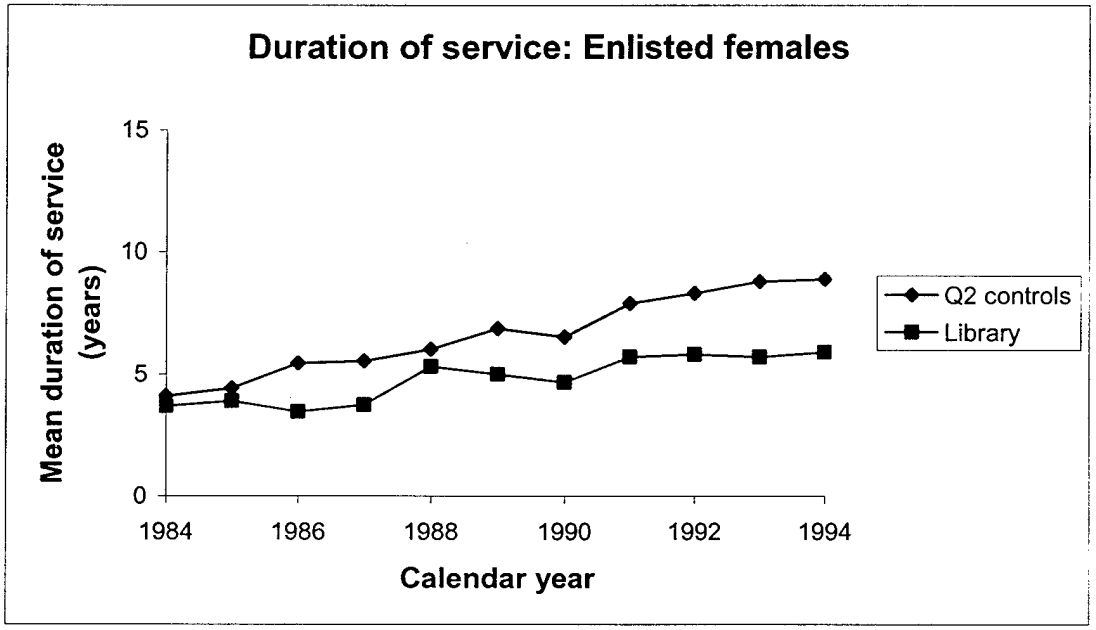
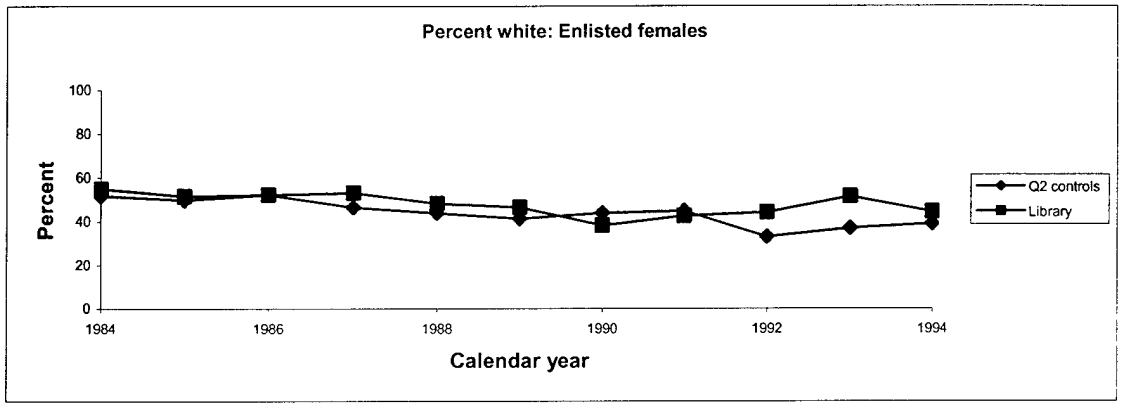
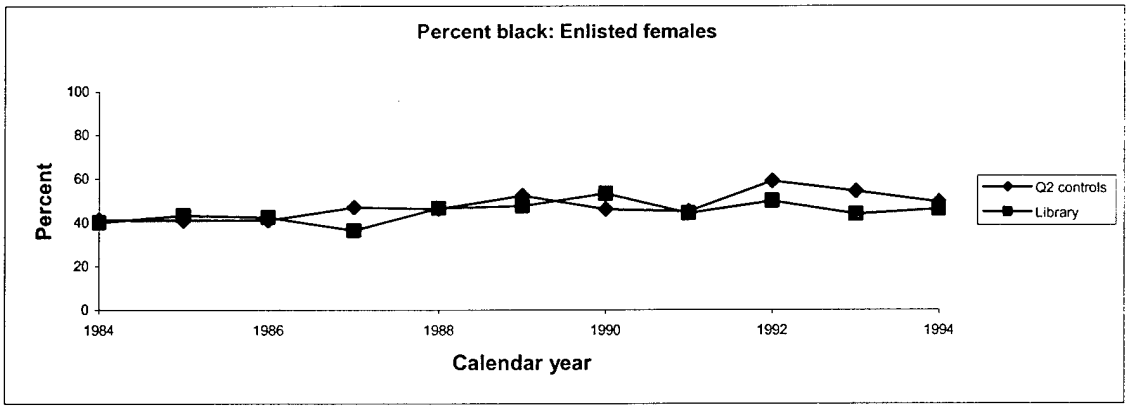


Figure D.11. Distribution of all Race/Ethnicity among Female Data Library Controls and Controls from Question 2 Analysis Set, By Year, 1984-1994





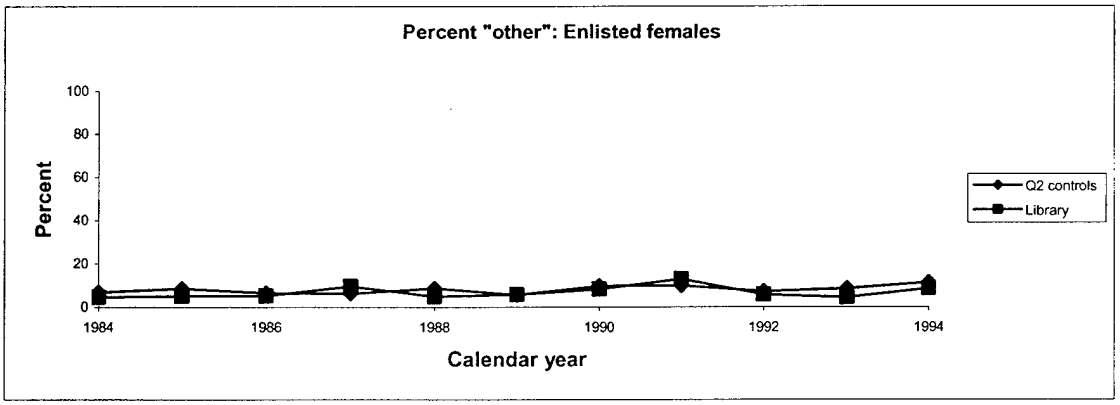
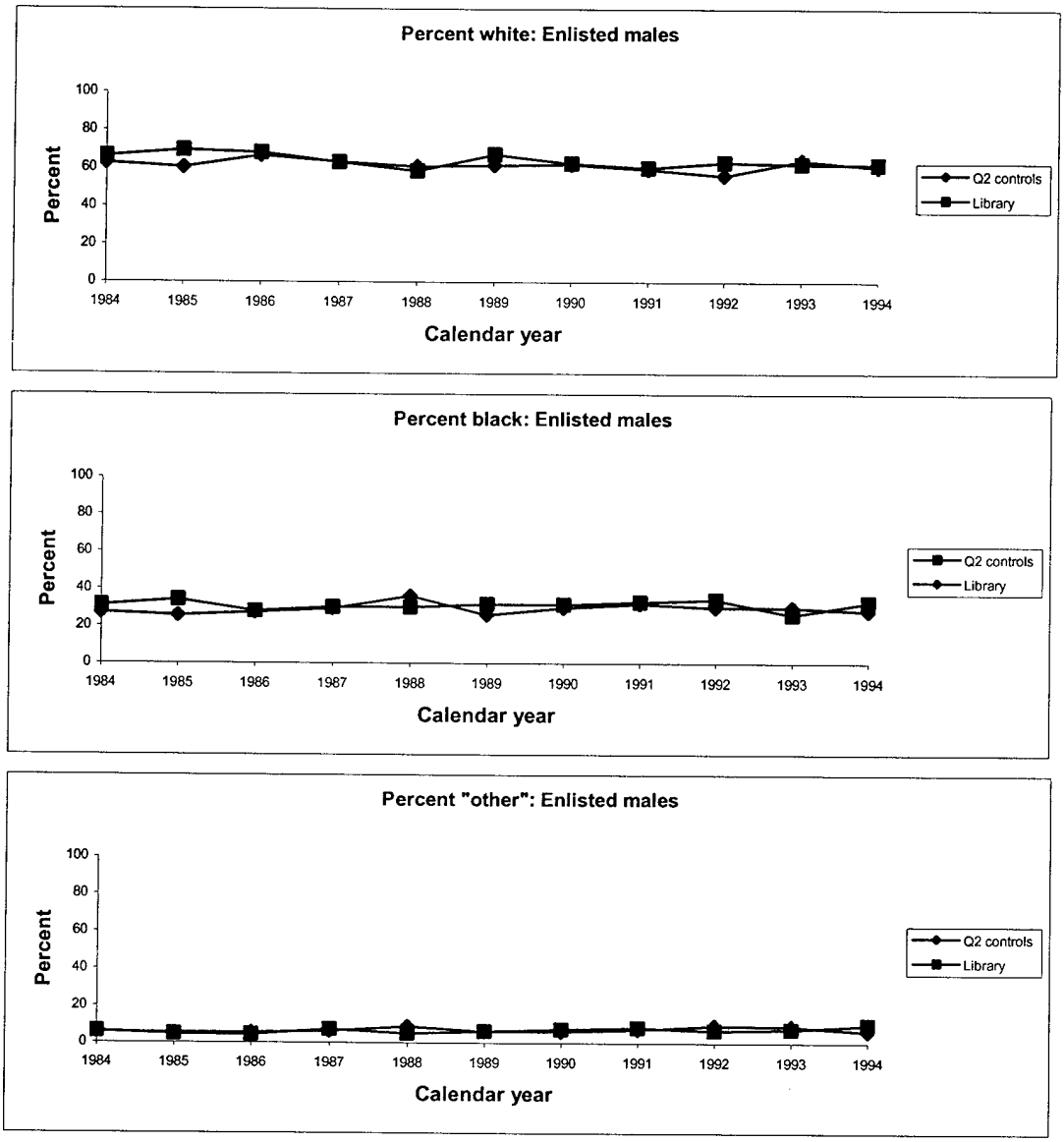


Figure D.12. Distribution of all Race/Ethnicity among Male Data Library Controls and Controls from Question 2 Analysis Set, By Year, 1984-1994



APPENDIX E. DEFINITION OF TERMS AND SELECTION OF ELIGIBILITY WINDOW

DEFINITION OF TERMS

The cohort: All enlisted personnel on active duty between 1980 and 1997.

The study period: January 1, 1980 through December 31, 1997.

The eligibility period: The time interval during which new cases are eligible for inclusion in the study as cases. Any cases that occurred outside of the eligibility period are not eligible to be included as cases in the study.

Enrollment date: latest of (beginning of eligibility period or date of enlistment in the Army).

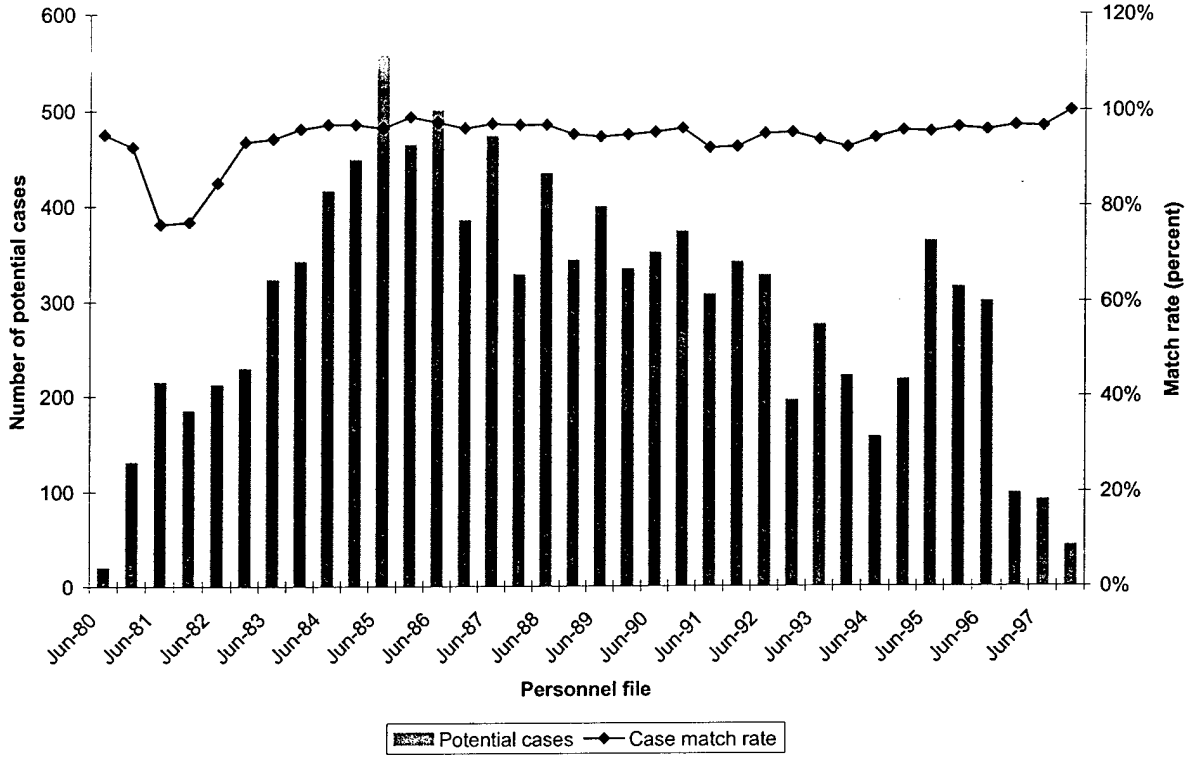
Procedural interval: Time required for completion of the process of determining disability following injury.

The follow-up period: from latest of (Army enlistment date or 1/1/80) to earliest of (event date or date of discharge from Army or 12/31/97).

SELECTION OF ELIGIBILITY WINDOW

The database (TAIHOD) covers the period 1/1/80 through 12/31/97. However, it may be inappropriate to include cases from all years in the database, for two reasons. First, the database may be less complete for 1980-1982, the first years for which data are recorded, compared to the rest of the study period (1983-1997). Figure E.1 shows the number of potential cases of knee-related disability discharge recorded in the disability file, and the proportion of the potential cases that had matches in the appropriate personnel file. Note that the smallest number of cases was recorded in June 1980. Also note that, beginning in December 1982, the case match rate is consistently above 90% for all intervals.

Figure E.1. Cases of Knee-Related Disability Discharge from the U.S. Army, 1980-1997, Matching to Semi-Annual Personnel Files (Contains Enlisted, NCO, Officers, and Personnel with Missing Data for Gender)



The disability determination in the Army represents the conclusion of an administrative process. There may be a minimum period of time required for the completion of the process, the "procedural interval." If so, then failing to take this interval into account will result in a bias towards the null, especially for research question 3. The bias would result from misclassifying as controls individuals with knee-related hospitalization but without disability discharge simply because the hospitalization occurred late in the study period. Research question 3 is designed to identify differences between knee injuries (defined by knee-related hospitalization) that lead to disability discharge and those that do not lead to disability discharge. Truncating the eligibility period at some time prior to 12/31/97 would allow sufficient time to elapse after the knee hospitalization for the process leading to discharge from the Army to conclude.

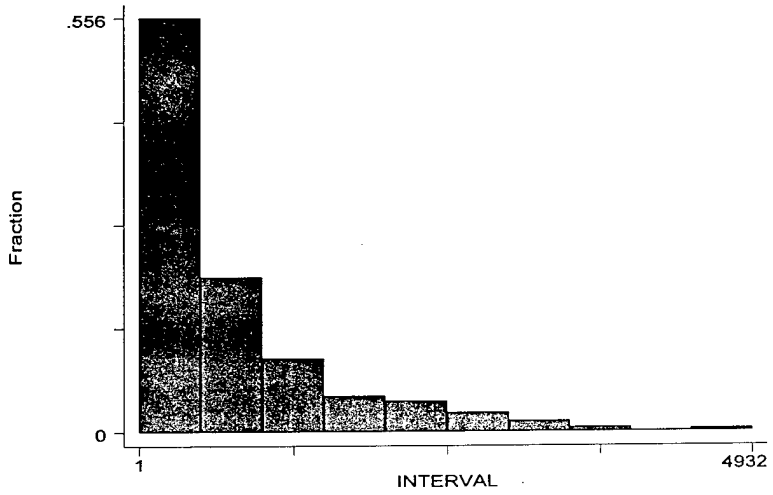
Steps to determine the appropriate eligibility period:

1. Identify the distribution of procedural intervals, using pilot study data. To determine earliest start date for eligibility window, evaluate the average interval between knee-related hospitalization and knee-related disability discharge for cases in the pilot study data library.
2. Determine how many cases in the current data library would be lost by truncating the eligibility period at various years.

RESULTS

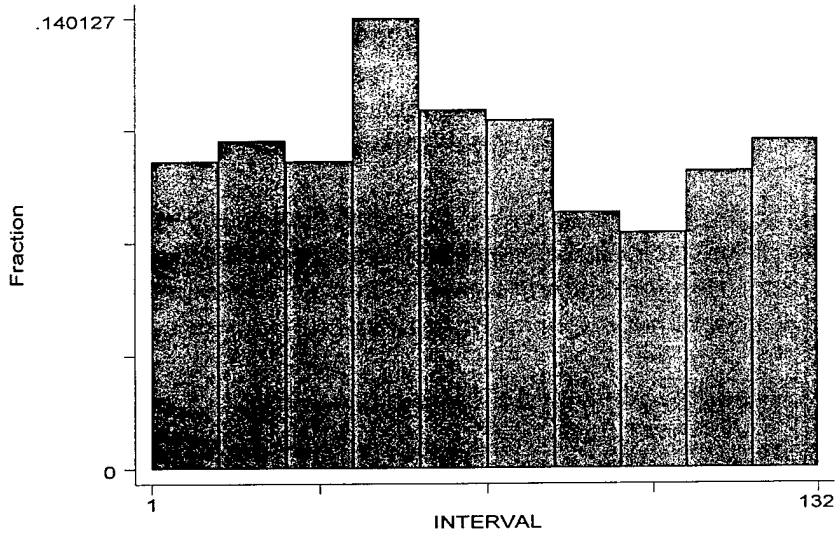
Procedural intervals: time between knee-related hospitalization and disability discharge. In the pilot study data set, there are N=1,250 cases with identifiable knee-related hospitalizations. The mean interval between hospital admission date and date of first discharge from the Army is 697.3 days, or 1.98 years; the range of intervals is 1 to 4932 days (14 years). The distribution of intervals between hospitalization and discharge from the Army is shown in Figure E.2.

Figure E.2. Interval Between Hospital Admission Date and Date of First Discharge from the U.S. Army among N=1,245 Cases from the Pilot Study with Knee-Related Hospitalizations (Mean Interval=697.3 Days (1.98 Years); Range=1 to 4,932 Days (14 years))



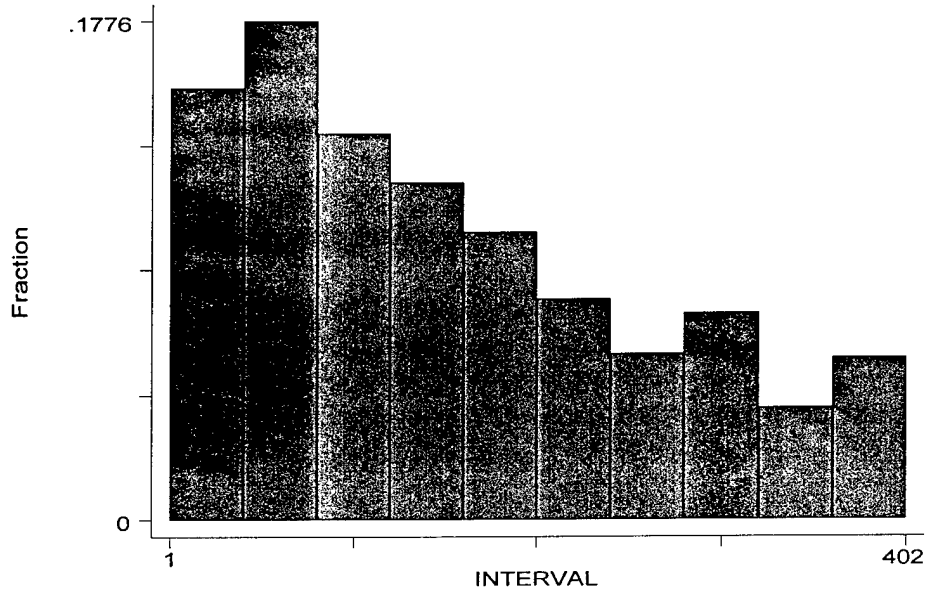
For cases whose interval between hospitalization and discharge is in the first quintile of the distribution (1-132 days), the mean interval is 64.2 days (Figure E.3).

Figure E.3. Interval Between Hospital Admission Date and Date of First Discharge from the U.S. Army among Cases from the Pilot Study with Knee-Related Hospitalizations Whose Interval Is in the First Quintile of the Distribution of Intervals (1-132 days; Mean=64.2 Days)



Among cases whose procedural interval is less then or equal to the median number of days, (1-402.5), the mean interval is 154.2 days (Figure E.4).

Figure E.4. Interval Between Hospital Admission Date and Date of First Discharge from the U.S. Army among Cases from the Pilot Study with Knee-Related Hospitalizations Whose Interval Is In the First Half of the Distribution of Intervals (1-402.5 days; Mean=154.2 Days)



These results suggest a minimum procedural interval of 2 years, so the eligibility period should begin no earlier than January 1, 1982. Beginning the eligibility period in 1982 would allow, for a large proportion of cases of knee disability discharge, sufficient time (up to 2 years) to elapse after the knee hospitalization for the disability determination to be made.

Determine how many cases in the current data library would be lost by truncating the eligibility period at various points.

Table E.1. Cases of Knee-Related Disability Discharge in the U.S. Army, 1980-1997

	Men (N=8634)			Women (N=1000)		
	Annual	Cumulative	Leaves	Annual	Cumulative	Leaves
1980	119	119	8515	6	6	994
1981	257	376	8258	31	37	963
1982	319	695	7939	40	77	923
1983	549	1244	7390	52	129	871
1984	714	1958	6676	87	216	784
1985	819	2777	5857	113	329	671
1986	742	3519	5115	75	404	596
1995	541	4060	4574	87	491	509
1996	307	4367	4267	63	554	446
1997	107	4474	4160	19	573	427

If the eligibility window were set from January 1, 1986, through December 31, 1994, then a total of (8,634-(2777+955)= 4902 men and (1,000-(329+169)=502 women with a knee-related disability discharge would be included in the data library.

Alternatively, if the eligibility window were set from January 1, 1984, through December 31, 1994, then a total of (8634-(1244+955)=6435 men and (1000-(129+169))=702 women would be included in the data library.

CONCLUSIONS

One option is to modify the eligibility start and end dates for each of the three research questions. However, this is unattractive for 2 reasons. First, one of the goals of this research is to compare risk factors for injuries that lead to disability with risk factors for injuries that do not lead to disability (research question 3). If we use different eligibility periods for the various analyses, then critics might argue that the direct comparison of results across analyses is inappropriate, since slightly different populations at risk are involved. Second, the description of the study population will be much more straightforward if the eligibility window is the same for all three analyses. The eligibility period should be defined as January 1, 1984, through December 31, 1994. If we use this period, we will include sufficient numbers of women (N=702 for research question 1) for adequately powered gender-specific analyses while still allowing for a long enough procedural interval to elapse (3 years at the beginning and at the end of the study period).

APPENDIX F: CHOICE OF OCCUPATIONAL EXPOSURES FOR EACH RESEARCH QUESTION

SELECTION OF APPROPRIATE JOB CODE FOR EACH RESEARCH QUESTION

March 1, 1999

This memo summarizes analyses of work history for cases and controls included in the data library. The goal of the analysis was to determine whether or not job code recorded at the time of the disability discharge represents the correct work exposure for research question 1, risk factors for disability discharge.

If job codes are stable over the period of active duty, and if the rate of job change for cases and controls is comparable, then this would be sufficient evidence to warrant using PMOS at discharge for research question 1 (risk factors for disability discharge). If there is no evidence for an increased or decreased rate of change in cases relative to controls, then PMOS change is not a risk factor for disability discharge.

The question of which job code to include in analyses of research questions 2 and 3 (risk factors for knee injury and differences between injuries leading to discharge, injuries not leading to discharge) is still open. I would appreciate your thoughts on this.

To evaluate whether or not the job code from time of the disability discharge represents the correct exposure, I obtained work history data for all personnel included in the data library. This file consists of one record per ID number with pay grade, Primary Military Occupational Specialty code (PMOS) and Duty Military Occupational Specialty code (DMOS) recorded in June and December of every calendar year between 1980 and 1997 during which an individual was on active duty. Since not every person in the data library worked every year between 1980 and 1997, the number of jobs recorded for each person varies.

For these analyses, I focused on the Primary Military Occupational Specialty code (PMOS), which represents a job for which a person received training. I assumed that a change in PMOS, as opposed to Duty MOS, would represent a durable change in assignment. Rachel Williams found in her Master's thesis work that PMOS is a more complete data field than DMOS, and that PMOS and DMOS are highly correlated ($r>0.90$) when both are available. Rachel evaluated work histories for all individuals in the pilot study data library (personnel on active duty between 1980-1994).

For each person in the data library, the 6-month rate of job changes is calculated as the number of changes in PMOS divided by the number of times any PMOS was recorded. The rate of PMOS change was 0.038 job/6 months for controls and 0.034 job/6 months for cases in the data library. For cases recorded in 1983 and later, I also evaluated the rate of PMOS change in the 4 years preceding discharge. The time interval is inclusive: it consists of the year of discharge and the 3 years prior to discharge. The rate of PMOS change for cases in the 4 years preceding discharge was 0.031 job/6 months.

For research questions 2 and 3, we can use the work history file to determine job code at approximately the time of first knee-related hospitalization (which is to be used as a surrogate for knee injury). Once the job at hospitalization is known, we can explicitly look for job changes around the time of the hospitalization for knee injury.

SELECTION OF APPROPRIATE JOB CODE FOR RESEARCH QUESTION 2: RISK FACTORS FOR KNEE-RELATED HOSPITALIZATION

July 9, 1999

Decision: The job recorded in the year preceding the first knee-related hospitalization will be used to represent work exposures for research question 2.

Definitions and Methods: For research question 2, cases are defined as individuals with a knee-related hospitalization based on diagnoses and/or procedures recorded in the hospital data file. There are 6456 potential cases and 21925 potential controls for research question 2, where the case-defining event is the first knee-related hospitalization. In order to determine which job in an individual's work history represents the correct exposure for question 2, I evaluated job stability using Primary Military Occupational Specialty (PMOS).

The work history file contains one record per ID. Pay grade, PMOS and Duty MOS (DMOS) were recorded in June and December of every calendar year between 1980 and 1997 during which a soldier was on active duty. Since not every person with work history data worked every year (nor did they work during the same years) between 1980 and 1997, the number of jobs recorded for each person varies.

For each person with work history data, I calculated the 6 month job change rate as the number of times the job code changed divided by the number of intervals with any job code recorded. For all potential cases and controls with work history data, I calculated the 6 month job change rate for the entire work history, and, for cases hospitalized after 1983 only, the job change rate during 1, 2 and 4 years preceding the hospital admission date (Table F.1). The 1983 cutoff date allows for the calculation of the change rate during the 4 years of data preceding hospital admission.

Table F.1. Work History for All Potential Cases and Controls for Research Question 2, Risk Factors for Knee-Related Hospitalization

	Controls (N=21,925)	Cases (N=2,316)			
	All	All	4 years *	2 years *	1 year *
Intervals (range, average)	0-36	0-36	0-8	0-4	0-2
	14.743	11.789	5.918	2.273	0.991
PMOS changes (range, average)	0-9	0-7	0-5	0-4	0-2
	1.603	1.468	1.237	0.782	0.555
Rate/6months (average)	0.036	0.037	0.039	0.035	0.022

* Work history for 4, 2, and 1 year prior to first hospital admission for a knee-related problem.

Results: The overall job change rate for cases and controls is very similar, 0.037/6 months and 0.036/6 months, respectively. The job change rate for cases during the 4 years and during the 2 years preceding first knee hospitalization is similar to the overall job change rate for cases. However, in the year immediately preceding first knee-related hospitalization, the job change rate is nearly halved, to 0.022/6 months.

A job change in the period immediately preceding knee-related hospitalization might reflect either riskier or more unfamiliar work. It could also reflect some level of work accommodation if the hospitalization represents the worsening of a chronic condition or the non-healing of an old injury. To explore this question, I evaluated the job change rate during 1, 2 and 4 years prior to the first knee hospitalization according to the chronicity (acute, chronic, or mixed) of the condition(s) leading to the hospitalization, based on the diagnoses recorded in the hospital file.

Table F.2 shows that the job change rate at 1, 2 and 4 years prior to first knee-related hospitalization is essentially the same for acute, chronic, and mixed acute/chronic conditions. The job change rates at 2 and 4 years prior to hospitalization are similar (about 0.04/6 months). During the year preceding hospitalization, the job change rate is approximately halved (0.02/6 months). Note that the majority of hospitalizations are categorized as "mixed".

Table F.2. Work History for Potential Cases for Research Question 2, Stratified by Chronicity of Condition(s) Leading to First Knee-Related Hospitalization

		Question 2 cases					
CHRONICITY		4 years*		2 years*		1 year*	
		Range	Mean	Range	Mean	Range	Mean
Acute (N=427)	Intervals	1-8	5.597	0-4	2.030	0-2	0.859
	PMOS	1-5	1.220	0-3	0.728	0-2	0.480
	Rate**		0.037		0.031		0.020
Chronic (N=340)	Intervals	0-8	6.356	0-4	2.638	0-2	1.188
	PMOS	0-4	1.268	0-3	0.879	0-2	0.662
	Rate**		0.042		0.038		0.018
Mixed (N=1492)	Intervals	0-8	5.895	0-4	2.251	0-2	0.979
	PMOS	0-5	1.235	0-4	0.772	0-2	0.549
	Rate**		0.0396		0.035		0.024

* Work history for 4, 2, and 1 year prior to first hospital admission for a knee-related problem.
** Average number of job changes per 6 months

RESEARCH QUESTION 2: RISK FACTORS FOR KNEE-RELATED HOSPITALIZATION

July 15, 1999

I. Analytic subset of controls

As described in the memo of July 13, 1999, the analytic subset for research question 2 consists of 1500 cases and 4500 controls. Controls comprise an incidence density sample, stratified by sex. By definition, a case can be a case only once, but anyone who has not yet been defined as a case is eligible to be a control in any number of risk sets. In evaluating the sample of controls selected for research question 2, I found that 4127/4500 individuals were selected in only one risk set. Three hundred thirty-nine were selected in 2 risk sets, and 17 were selected in three risk sets. I used the same algorithms that I used in the construction of the data library and the analytic subsample for question 1. Both of those samples had only a small number of instances of controls selected into more than one risk set. Does this seem like a bad-luck sample? In other words, is there a reason to be concerned about this?

II. Work exposures

Based on the analyses described in the memo of July 9, 1999, the work exposures for research question 2 should be based on the job held within year preceding the end of follow-up. For the cases, end of follow-up is the date of first knee-related hospital admission. For controls, end of follow-up is the year of a case hospitalization (controls were selected in proportion to the number of cases recorded in a given year). For convenience, let's call the end of follow-up admission year. Since the work history file records jobs and pay grades in June and December of each calendar year, and since some data within work history records are missing, I extracted job code (PMOS, Primary Military Occupational Specialty) and pay grade in this order of preference:

1. Recorded in June of admission year;
2. Recorded in December of admission year;
3. Recorded in December of year before admission year;
4. Recorded in June of year before admission year.

Even with this relatively loose algorithm, PMOS was available for only 47% (2098/4500) controls included in the analytic subset for question 2. There was absolutely no change by considering DMOS, Duty Military Occupational Specialty, in the absence of PMOS. A spot check of records showed that, in fact, if PMOS is missing from a record, so are DMOS and pay grade. In contrast, 91% (1365/1500) of the cases have PMOS and pay grade from 1-2 years prior to admission year, using the same choices listed above.

APPENDIX G: DATA QUALITY AND COMPLETENESS

Data quality assessment for question 1 analytic subset
03-Mar-99

Personnel data

File name:	q1pers.sd2
Number of records	6810
Number of cases:	1703
Number of controls:	5107

Variable	Label	Low value	High value	Obs	Missing
ID	Study ID number	2	23380	6810	0
DISABDTE	Disability date (cases)	01/31/1984	12/29/1994	1703	5107
DISYR	Year of case disability	1984	1994	6810	0
DISMO	Month of disability (cases)	1	12	1703	5107
TAFMS	Total Active Federal-Military Service (months)	0	362	6810	0
DDOC	DoD Duty Occupational code	000		6810	0
HYEC	Education			6810	0
PERGRADE	Pay grade (personnel)	E1	E9	6810	0
DOB_J	Date of birth	07/20/1933	11/22/1976	6805	5
RACE	Race	0	3	6810	0
MS	Marital Status	0	3	6810	0
DEPS	Dependents	0	9	6810	0
HYEC2	Highest year of education	0	19	6810	0
RETHNIC	Race/ethnicity	0	6	6810	0
PER_SEX	Sex (personnel)	1	2	6810	0
DSOC	DoD Secondary-Occupation code	000	003	6810	0
PMOS	Primary military-occupational specialty code			6795	15
DOR_Y	Date of rank-year	0	94	6810	0
DOR_M	Date of rank-month	0	12	6810	0
DMOS	Duty MOS			5872	938
ACMF	Army career-management field			6477	333
ASC	Army status code			3819	2991
HYEE	Highest year of - education at entry			6810	0
MS_DEP	Marital Status/dependents	0 (N=285)	26 (Married, 6 dep)	6810	0
ASVAB1	ASVAB raw score	1 (N=97)	131	1703	5107
TERM1	Years of contracted service1	0	8	6810	0
TERM2	Years of contracted service2	0	8	6810	0
AFQT_E	Aptitude test percent at entry	0 (N=882)	99	6810	0
HT	Height	0 (N=5239)	77	6810	0
WT	Weight	0 (N=5242)	99	6810	0
SMOS	Secondary MOS			1823	4987
CO	Composite score (CO)	0 (N=4137)	143	6810	0

Variable	Label	Low value	High value	Obs	Missing
CL	Composite score (CL)	0 (N=4136)	132	6810	0
BASD_J	Basic Active Service Date	08/10/1954	12/01/1994	6808	2
PEBD_J	Pay entry base date	10/13/1954	09/14/1994	1703	5107
DOE_J	Date of entry	07/07/1970	12/01/1994	6549	261
SRCFILE	June or December pers. File	1	2	6810	0
DISAB	Disability discharge	1	2	1703	5107
AGE	Age=				
	(disability year-year of birth)	17	53	6805	5
CASEID	Case identifier	0	1	6810	0
AFQT_PCT	Aptitude test percentile, entry	0	99	5107	1703
DATEOUT	Date of separation				

Data quality assessment for question 1 analytic subset
03-Mar-99

Disability data

File name:	q1csdis.sd2, q2ctdis.sd2
Number of records	1779
Number of cases:	1703
Number of controls:	76

Variable	Label	Low	High	Obs	Missing
ID	Study ID number	12	28320	1779	0
DISABDTE	Disability date (cases)	01/03/84	12/29/94	1779	0
DISYR	Year of case disability	1984	1994	1779	0
CASEID	Case identifier	0	1	1779	0
DISMO	Month of disability date (cases)	1	12	1703	76
D_RECEIV	Date report rec'd - by Phys. Eval. Board	03/31/1982	05/11/1995	1777	2
PDAPER	Percent disability - from PDA (1980-88)	0	100	1129	650
PEBPER	Percent disability - from PEB (1980-88)	0	100	1129	650
MEDBOARD	Date of medical-eval board hearing	01/05/82	04/18/95	1773	6
PHYSICAL	Date of last physical exam (1989-97)	06/27/89	12/29/94	556	1223
RESULT_D	Result date	11/07/89	06/09/96	650	1129
COMPONEN	Service component			1779	0
GRADE	Pay grade (disability)	E1	O5	1777	2
CASE_TYP	Case type			1778	1
LOD	Line of duty			1116	663
PEBDIS	Disposition by - PEB (1980-88)			1129	650
FINAL_RS	Final result code			1771	8
DIAGCD	Specific condition - code (1980-88)			102	1677

Variable	Label	Low	High	Obs	Missing
GENDER	Sex (disability)	m	f	1776	3
EXDTE	Date of original - exam at MTF	01/05/82	12/04/89	1129	650
VASRD_1	Primary disability code			1753	26
VASRD_2	Secondary disability code			1267	512
FLAG80	Flag=1 if from 1980-88 file	0	1	1779	0
PERCENTA	Total % disability (1989-97)	0	100	634	1145
DISPOSIT	Disposition codes (1989-97)			649	1130
ANALOG_1	Analogous code - for VASRD1 (1989-97)			205	1574
PERCENT1	Percent disability, VASRD1 (1989-98)	0	100	622	1157
ANALOG_2	Analogous code -			36	1743
	for VASRD2 (1989-97)			36	1743
PERCENT2	Percent disability, VASRD2 (1989-98)	0	90	127	1652
VASRD_3	Third disability (1989-97)			37	1742
ANALOG_3	Analogous code - for VASRD3 (1989-97)			11	1768
PERCENT3	Percent disability, VASRD3 (1989-97)	0	100	40	1739
VASRD_4	Fourth disability (1989-97)			13	1766
ANALOG_4	Analogous code -			6	1773
	for VASRD4 (1989-97)			6	1773
PERCENT4	Percent disability, VASRD4 (1989-97)	0	30	12	1767
COMBAT	Occurred during combat?	F	T	650	1129
ON_DUTY	Occurred on duty?	F	T	650	1129
COMBAT_R	Combat related?	F	T	650	1129

Data quality assessment for question 1 analytic subset
03-Mar-99

Hospital data
File name: q1hosp.sd2

Number of records 7254
Number of cases: 3266
Number of controls: 3988

Variable	Label	Low	High	Obs	Missing
ID	Study ID number	12	28377	7254	0
DISABDTE	Disability date (cases)	01/03/84	12/15/94	3266	3988
DISYR	Year of case disability	1984	1995	3988	3266
PER_SEX	Sex (personnel)	1	2	7254	0
CASEID	Case identifier	0	1	7254	0
DISAB	Disability discharge (yn)	1	2	7254	0
DIAG_P	Primary diagnosis			7254	0
DATE_D	Date of disposition	01/03/80	12/12/1994	7254	0
DSPO	Disposition codes			7254	0
GRADE	Pay grade (hospital)	u	1	7254	0
FMP	Family member prefix	20	20	7254	0
PAT_CAT	Patient category - (duty status)			7254	0
TRAUMA	Trauma code			1310	5944
INJURY	External cause of injury			1486	5768
DIAG_2	Second diagnosis			3367	3387
DIAG_3	Third diagnosis			1460	5794
DIAG_4	Fourth diagnosis			613	6641
DIAG_5	Fifth diagnosis			277	6977
DIAG_6	Sixth diagnosis			160	7094
DIAG_7	Seventh diagnosis			97	7157
DIAG_8	Eighth diagnosis			58	7196
PROC_P	Principle procedure			6615	639
PROC_2	Second procedure			5994	1260
PROC_3	Third procedure			5582	1672
PROC_4	Fourth procedure			5358	1896
PROC_5	Fifth procedure			5266	1988
PROC_6	Sixth procedure			5227	2027
PROC_7	Seventh procedure			5213	2041
PROC_8	Eighth procedure			36	7218
DATE_I	Date initial admission			5330	1924
DATE_T	Date this admission			7214	40
CC_C	Complications - Comorbidities (CHAMPUS)	N Y		2061	5193
CC_H	Complications - Comorbidities (HCFA)	N Y		2061	5193
LEN_SER	Duration of service (1999-97)			2061	5193

Data quality assessment for question 1 analytic subset
03-Mar-99

CRO data

File name:	q1cro.sd2
Number of records	514
Number of cases:	514
Number of controls:	0

Variable	Label	Low	High	Obs	Missing
ID	Study ID number	192	28234	7254	0
DISABDTE	Disability date (cases)	03/10/87	10/31/86	3266	3988
DISYR	Year of case disability	1984		3988	3266
PER_SEX	Sex (personnel)	1	2	7254	0
CASEID	Case identifier	0	1	7254	0
DISAB	Disability discharge (yn)	1	2	7254	0
DIAG_P	Primary diagnosis			7254	0
DATE_D	Date of disposition	07/16/85	08/30/95	7254	0
DSPO	Disposition codes			7254	0
GRADE	Pay grade (hospital)	E4	E9	7254	0
FMP	Family member prefix	20	20	7254	0
PAT_CAT	Patient category-(duty status)			7254	0
TRAUMA	Trauma code			1310	5944
INJURY	External cause of injury			1486	5768
DIAG_2	Second diagnosis			3367	3387
DIAG_3	Third diagnosis			1460	5794
DIAG_4	Fourth diagnosis			613	6641
DIAG_5	Fifth diagnosis			277	6977
DIAG_6	Sixth diagnosis			160	7094
DIAG_7	Seventh diagnosis			97	7157
DIAG_8	Eighth diagnosis			58	7196
PROC_P	Principle procedure			6615	639
PROC_2	Second procedure			5994	1260
PROC_3	Third procedure			5582	1672
PROC_4	Fourth procedure			5358	1896
PROC_5	Fifth procedure			5266	1988
PROC_6	Sixth procedure			5227	2027
PROC_7	Seventh procedure			5213	2041
PROC_8	Eighth procedure			36	7218
DATE_I	Date initial admission			5330	1924
DATE_T	Date this admission			7214	40
CC_C	Complications - comorbidities (CHAMPUS)	N	Y	2061	5193
CC_H	Complications - comorbidities (HCFA)	N	Y	2061	5193
LEN_SER	Duration of service (1999-97)			2061	5193

Data quality assessment/summary for question 2 subset
8/5/99

File name: q2case4, q2ctrl3
Number of records: 7211
Number of cases: 1364
Number of controls: 5847

Variable	Label	Low	High	Obs	Missing
HYEC	Educational attainment	Unknown	Alternate	7211	0
DOB_J	Date of birth	17-May-31	20-Jul-75	7210	1
RACE	Race	0=Unknown	3=Other	7211	10
MS	Marital status	0=Unknown	3=No longer marr'd	7211	115
DEPS	Number of dependents	0	9	7211	0
RETHNIC	Race/ethnicity	0=Unknown	6=Other		1
Sex	Sex	1=Male	2=Female	7211	0
HYEE	Education at Entry	0=Unknown	14=Alt credent		325
HT	Height (inches)	58	77	995	6216
WT	Weight	1	99	989	6222
BASD_J	Basic Active Service Date	30MAR53	06DEC93	7210	1
DOE_J	Date of Entry	07JUL70	25JAN95	6889	322
DISAB	Disability discharge	1=yes	2=no	7211	0
DIAG_P	Primary diagnosis	529	V718	1364	5847
DATE_D	Date of disposition - (hosp discharge)			1364	5847
DSPO	Disposition	01: return to duty	M=Separation, other	1363	5848
GRADE	Pay grade (at 1-2 years<hosp year)	1	9	7211	0
FMP	Family member prefix	Primary beneficiary	Primary beneficiary	1364	5847
PAT_CAT	Patient category	A11=Active duty	A11=Active duty	1364	5847
TRAUMA	Trauma code	1: Other battle	9: Unknown	489	6722
INJURY	External cause of injury	10	998	555	6656
DIAG_2	Second dx	799	V653	819	6392
DIAG_3	Third dx	411	V660	382	6829
DIAG_4	Fourth dx	417	V641	169	7042
DIAG_5	Fifth dx	411	V540	77	7134
DIAG_6	Sixth dx	780	V5789	49	7162
DIAG_7	Seventh dx	703	V14	37	7174
DIAG_8	Eigth dx	416	9664	26	7185
PROC_P	Principal procedure	159	9923 1D	1282	5929
PROC_2	Second procedure	125	9929 1D	1112	6099
PROC_3	Third procedure	0212 1C	9921 2D	848	6363
PROC_4	Fourth procedure	0299 1D	9986 1D	726	6485
PROC_5	Fifth procedure	3429 1D	9788 1D	697	6514
PROC_6	Sixth procedure	3409 1D	9999 1D	686	6525
PROC_7	Seventh procedure	0881 1D	9925 2D	679	6532
PROC_8	Eighth procedure	3440 1D	9904 9D	674	6537
DATE_I	Date initial admx	840208	940925	707	6504

Variable	Label	Low	High	Obs	Missing
DATE_T	Date this admx	840104	941218	1356	5855
CC_C	Complic/comorbid - (CC) indicator	N	Y	695	6516
CC_H	8996: Complic/comorbid - (CH) indicator	N N	Y Y	695 695	6516 6516
LEN_SER	8997: Duration of svc	M01	ZZZ	695	6516
SURG	Any knee surgery?	0=No	1=Yes	1364	5847
KNEEHSP	Knee admission	1=Yes		1364	5847
DX1	Knee dx position 1?	0=No	1=Yes	1364	5847
DX2	Knee dx position 2?	0=No	1=Yes	1364	5847
DX3	Knee dx position 3?	0=No	1=Yes	1364	5847
DX4	Knee dx position 4?	0=No	1=Yes	1364	5847
DX5	Knee dx position 5?	0=No	1=Yes	1364	5847
DX6	Knee dx position 6?	0=No	1=Yes	1364	5847
DX7	Knee dx position 7?	0=No	1=Yes	1364	5847
DX8	Knee dx position 8?	0=No	1=Yes	1364	5847
P1	Knee proc position 1?	0=No	1=Yes	1364	5847
P2	Knee proc position 2?	0=No	1=Yes	1364	5847
P3	Knee proc position 3?	0=No	1=Yes	1364	5847
P4	Knee proc position 4?	0=No	1=Yes	1364	5847
P5	Knee proc position 5?	0=No	1=Yes	1364	5847
P6	Knee proc position 6?	0=No	1=Yes	1364	5847
P7	Knee proc position 7?	0=No	1=Yes	1364	5847
P8	Knee proc position 8?	0=No		1364	5847
PTY1	Procedure type,position 1	0=none	3=Mixed	1364	5847
PTY2	Procedure type,position 2	0=none	3=Mixed	1364	5847
PTY3	Procedure type,position 3	0=none	3=Mixed	1364	5847
PTY4	Procedure type,position 4	0=none	2=Bony tissue	1364	5847
PTY5	Procedure type,position 5	0=none	3=Mixed	1364	5847
PTY6	Procedure type,position 6	0=none	2=Bony tissue	1364	5847
PTY7	Procedure type,position 7	0=none		1364	5847
PTY8	Procedure type,position 8	0=none		1364	5847
KPROC_N	Count knee procedures per admx	0	4	5847	5847
INJTY11	Acute vs. chronic , dx1	All acute	Mixed	1126	6085
INJTY12	Acute vs. chronic , dx2	All acute	Mixed	592	6619
INJTY13	Acute vs. chronic , dx3	All acute	Mixed	128	6984
INJTY14	Acute vs. chronic , dx4	All acute	Mixed	87	7124
INJTY15	Acute vs. chronic , dx5	All acute	Mixed	24	7187
INJTY16	Acute vs. chronic , dx6	All acute	Mixed	14	7197
INJTY17	Acute vs. chronic , dx7	All acute	Mixed	9	7202
INJTY18	Acute vs. chronic , dx8	All chronic	Mixed	4	7207
INJTY21	Soft vs. hard tissue, dx1	All soft	All bone	1126	6085
INJTY22	Soft vs. hard tissue, dx2	All soft	All bone	592	6619
INJTY23	Soft vs. hard tissue, dx3	All soft	All bone	227	6894
INJTY24	Soft vs. hard tissue, dx4	All soft	All bone	87	7124
INJTY25	Soft vs. hard tissue, dx5	All soft	All bone	24	7187
INJTY26	Soft vs. hard tissue, dx6	All soft	All bone	14	7197
INJTY27	Soft vs. hard tissue, dx7	All soft	All bone	9	7202
INJTY28	Soft vs. hard tissue, dx7	All bone		4	7207
ADMTY1	Admission for acute, chronic, mixed	All acute	Mixed	1272	5939

Variable	Label	Low	High	Obs	Missing
ADMTY2	Admission for soft, hard tiss.	All soft	Mixed	1364	5847
ADATE	Admission date (cases only)	04-Jan-84	18DEC94	1364	5847
IDTE	Initial admission date	8804	12686	67	7144
TDTE	This admission date	8769	12770	1350	5861
IYR	Year initial admission date	84	94	67	7144
IMO	Month initial admission date	1	12	67	7144
IDAY	Day initial admission date	1	31	67	7144
TYR	Year this admission date	84	94	1350	5861
TMO	Month this admission date	1	12	1350	5861
TDAY	Day this admission date	1	31	1350	5861
KDX_N	Count knee diagnoses/admx	0	7	1364	5847
AYR	Year of admx (ca and ctrl)	1984	1994	7211	0
AGE	Age at 1-2 years< AYR	18	59	7210	1
SVC	Months of svc at admit date	0	696.42	7210	1
CCID	Case ID	0	1	7211	0
JOB	PMOS 1-2 years<AYR	00B	98Z	7203	8
DATEOUT	Date of separation	8771	13665	115	7096
DTE_IN	Earliest date of entry to Army	-2468	12389	5847	1364
YR_IN	Year of DTE_IN	1953	1993	5847	1364
YR_OUT	Year of separation	1984	1997	115	7096
INJCAT	Category of injury (cases)	1: Air transport	12: Fall, misc, NOS	555	6656

APPENDIX H: DATA DICTIONARIES

Q1ANAL.SD2: Analytic Dataset for Research Question 1: Risk Factors for Knee-Related Disability Discharge from the U.S. Army

Observations: 6810
Variables: 86

Alphabetic listing

Variable	Type	Len	Posit	Label	Format	Codes	Values
AGEGR5	Num	8	102	Quintiles of age	AGEGR	1	1: 17-20 years
						2	2: 21-22 years
						3	3: 23-25 years
						4	4: 26-32 years
						5	5: 33-60 years
AGEQ1	Num	8	62	Q1: Age 17-20	YNNFMT	0	0=No
						1	1=Yes
AGEQ2	Num	8	70	Q2: Age 21-22	YNNFMT	0	0=No
						1	1=Yes
AGEQ3	Num	8	78	Q3: Age 23-25	YNNFMT	0	0=No
						1	1=Yes
AGEQ4	Num	8	86	Q4: Age 26-32	YNNFMT	0	0=No
						1	1=Yes
AGEQ5	Num	8	94	Q5: Age 33-60	YNNFMT	0	0=No
						1	1=Yes
CASEID	Num	8	17	Case/control ID	CIDFMT	0	0=Control
						1	1=Case
CMF1	Num	8	198	INFANTRY/GUN CREWS	YNNFMT	0	0=No
						1	1=Yes
CMF2	Num	8	206	ELECTR EQUIP REPAIR	YNNFMT	0	0=No
						1	1=Yes
CMF3	Num	8	214	COMMUN/INTEL L	YNNFMT	0	0=No
						1	1=Yes
CMF4	Num	8	222	HEALTHCARE	YNNFMT	0	0=No
						1	1=Yes
CMF5	Num	8	230	TECHNIC/ALLIED SPECIAL	YNNFMT	0	0=No
						1	1=Yes

CMF6	Num	8	238	SUPPORT/ADMIN	YNNFMT	0	0=No
						1	1=Yes
CMF7	Num	8	246	ELECT/MECHAN EQUIP REP	YNNFMT	0	0=No
						1	1=Yes
CMF8	Num	8	254	CRAFTSWORKER	YNNFMT	0	0=No
						1	1=Yes
CMF9	Num	8	262	SERVICE/SUPPLY	YNNFMT	0	0=No
						1	1=Yes
CMF10	Num	8	270	NON-OCCUPATIONAL	YNNFMT	0	0=No
						1	1=Yes
ENLIST2	Char	5	57	Enlisted career management group	$ENLIST.	0	INFANTRY/GUN CREWS
						1	ELECTR EQUIP REPAIR
						2	COMMUN/INTELL
						3	HEALTHCARE
						4	TECHNIC/ALLIED SPECIAL
						5	SUPPORT/ADMIN
						6	ELECT/MECHAN EQUIP REP
						7	CRAFTSWORKERS
						8	SERVICE/SUPPLY
						9	NON-OCCUPATIONAL
ID	Num	8	0	ID Number			
KNEEHSP	Num	8	466	Knee admission:any proced or diag	YNNFMT	0	0=No
						1	1=Yes
KNEEL	Num	8	33	Job tasks: Kneeling	KNEEL	1	None
						2	Prolonged
						3	While shoveling,lifting
						4	While filing
KNEEL1	Num	8	278	None	YNNFMT	0	0=No
						1	1=Yes
KNEEL2	Num	8	286	Prolonged	YNNFMT	0	0=No
						1	1=Yes
KNEEL3	Num	8	294	While shoveling, lifting	YNNFMT	0	0=No
						1	1=Yes
KNEEL4	Num	8	302	While filing	YNNFMT	0	0=No
						1	1=Yes

Variable	Type	Len	Pos	Label	Format	Codes	Values
LIFT	Num	8	25	Job task: Lift/carry	LIFT	1	None
						2	1-25 lbs
						3	25-50 lbs
						4	51-75 lbs
						5	76-100 lbs
						6	101-125 lbs
						7	126-150 lbs
						8	151-175 lbs
						9	Raises 267 lbs
LIFT1	Num	8	350	None	YNNFMT	0	0=No
						1	1=Yes
LIFT2	Num	8	358	1-25 lbs	YNNFMT	0	0=No
						1	1=Yes
LIFT3	Num	8	366	26-50 lbs	YNNFMT	0	0=No
						1	1=Yes
LIFT4	Num	8	374	51-75 lbs	YNNFMT	0	0=No
						1	1=Yes
LIFT5	Num	8	382	76=100 lbs	YNNFMT	0	0=No
						1	1=Yes
LIFT6	Num	8	390	101-125 lbs	YNNFMT	0	0=No
						1	1=Yes
LIFT7	Num	8	398	126-150 lbs	YNNFMT	0	0=No
						1	1=Yes
LIFT8	Num	8	406	151-175 lbs	YNNFMT	0	0=No
						1	1=Yes
LIFT9	Num	8	414	Raises 267 lbs	YNNFMT	0	0=No
						1	1=Yes
MS	Num	3	11	AM: Marital status	MSFMT	0	0=Unknown
						1	1=Single
						2	2=Married
						3	3=No longer married
MS2	Num	8	174	Married yes/no	YNNFMT	0	0=No
						1	1=Yes
NONWHITE	Num	8	190	Nonwhite race	YNNFMT	0	0=No
						1	1=Yes
PERGR	Num	8	422	Pay grade, personnel	EGR3FMT	1	1: Grade 0-3
						2	2: Grade 4-6
						3	3: Grade 7-9
PERGR1	Num	8	430	Grade E1-E3	YNNFMT	0	0=No
						1	1=Yes

Variable	Type	Len	Pos	Label	Format	Codes	Values
PERGR2	Num	8	438	Grade E4-E6	YNNFMT	0	0=No
						1	1=Yes
PERGR3	Num	8	446	Grade E7-E9	YNNFMT	0	0=No
						1	1=Yes
PER_SEX	Num	3	14	AM: Sex	SEXFMT	1	1=Male
						2	2=Female
PUPULL1	Num	8	310	None	YNNFMT	0	0=No
						1	1=Yes
PUPULL2	Num	8	318	<130 lbs	YNNFMT	0	0=No
						1	1=Yes
PUPULL3	Num	8	326	>=130 lbs	YNNFMT	0	0=No
						1	1=Yes
PUPULL4	Num	8	334	ft/lb force	YNNFMT	0	0=No
						1	1=Yes
PUPULL5	Num	8	342	Uses wrench	YNNFMT	0	0=No
						1	1=Yes
RACEGR2	Num	8	166	Race, dichotomized	RACEGR	1	White
						2	Nonwhite
SIT	Num	8	41	Job task: Any sitting	YNNFMT	0	0=No
						1	1=Yes
STAND	Num	8	49	Job tasks: Any standing	YNNFMT	0	0=No
						1	1=Yes
SURG	Num	8	458	Any knee procedure?	YNNFMT	0	0=No
						1	1=Yes
SVC	Num	8	158	Duration of service >=120 months	YNNFMT	0	0=No
						1	1=Yes
TAFGR5	Num	8	150	Quintiles of TAFMS	TAFGR	1	1:1-15 months
						2	2:16-32 months
						3	3:33-59 months
						4	4:60-119 months
						5	5:120-414 months
TAFMS	Num	3	8	AM: Total Active Federal Military Srvce			
TAFQ1	Num	8	110	Q1: 1-15 months	YNNFMT	0	0=No
						1	1=Yes

Variable	Type	Len	Pos	Label	Format	Codes	Values
TAFQ2	Num	8	118	Q2: 16-32 months	YNNFMT	0	0=No
						1	1=Yes
TAFQ3	Num	8	126	Q3: 33-59 months	YNNFMT	0	0=No
						1	1=Yes
TAFQ4	Num	8	134	Q4: 60-119 months	YNNFMT	0	0=No
						1	1=Yes
TAFQ5	Num	8	142	Q5: 120-414 months	YNNFMT	0	0=No
						1	1=Yes
WHITE	Num	8	182	Race: White	YNNFMT	0	0=No
						1	1=Yes

Listing by position

#	Variable	Type	Len	Pos	Label
1	ID	Num	8	0	ID Number
2	TAFMS	Num	3	8	AM: Total Active Federal Military Srvce
3	MS	Num	3	11	AM: Marital status
4	PER_SEX	Num	3	14	AM: Sex
5	CASEID	Num	8	17	
6	LIFT	Num	8	25	
7	KNEEL	Num	8	33	
8	SIT	Num	8	41	
9	STAND	Num	8	49	
10	ENLIST2	Char	5	57	Enlisted career management group
11	AGEQ1	Num	8	62	Q1: Age 17-20
12	AGEQ2	Num	8	70	Q2: Age 21-22
13	AGEQ3	Num	8	78	Q3: Age 23-25
14	AGEQ4	Num	8	86	Q4: Age 26-32
15	AGEQ5	Num	8	94	Q5: Age 33-60
16	AGEGR5	Num	8	102	Quintiles of age
17	TAFQ1	Num	8	110	Q1: 1-15 months
18	TAFQ2	Num	8	118	Q2: 16-32 months
19	TAFQ3	Num	8	126	Q3: 33-59 months
20	TAFQ4	Num	8	134	Q4: 60-119 months
21	TAFQ5	Num	8	142	Q5: 120-414 months
22	TAFGR5	Num	8	150	Quintiles of TAFMS
23	SVC	Num	8	158	Duration of service >=120 months
24	RACEGR2	Num	8	166	Race, dichotomized
25	MS2	Num	8	174	Married yes/no
26	WHITE	Num	8	182	
27	NONWHITE	Num	8	190	
28	CMF1	Num	8	198	
29	CMF2	Num	8	206	
30	CMF3	Num	8	214	
31	CMF4	Num	8	222	
32	CMF5	Num	8	230	
33	CMF6	Num	8	238	
34	CMF7	Num	8	246	

35	CMF8	Num	8	254	
36	CMF9	Num	8	262	
#	Variable	Type	Len	Pos	Label
37	CMF10	Num	8	270	
38	KNEEL1	Num	8	278	None
39	KNEEL2	Num	8	286	Prolonged
40	KNEEL3	Num	8	294	While shoveling, lifting
41	KNEEL4	Num	8	302	While filing
42	PUPULL1	Num	8	310	
43	PUPULL2	Num	8	318	
44	PUPULL3	Num	8	326	
45	PUPULL4	Num	8	334	
46	PUPULL5	Num	8	342	
#	Variable	Type	Len	Pos	Label
47	LIFT1	Num	8	350	None
48	LIFT2	Num	8	358	1-25 lbs
49	LIFT3	Num	8	366	26-50 lbs
50	LIFT4	Num	8	374	51-75 lbs
51	LIFT5	Num	8	382	76=100 lbs
52	LIFT6	Num	8	390	101-125 lbs
53	LIFT7	Num	8	398	126-150 lbs
54	LIFT8	Num	8	406	151-175 lbs
55	LIFT9	Num	8	414	Raises 267 lbs
56	PERGR	Num	8	422	
57	PERGR1	Num	8	430	
58	PERGR2	Num	8	438	
59	PERGR3	Num	8	446	
60	TRAUMA	Char	1	454	Trauma code
61	INJURY	Char	3	455	External cause of injury
62	SURG	Num	8	458	Any knee procedure?
63	KNEEHSP	Num	8	466	Knee admission:any proced or diag
64	TR0	Num	8	474	0: Enemy action
65	TR1	Num	8	482	1: Other battle
66	TR2	Num	8	490	2: Legal intervention
67	TR3	Num	8	498	3: Assault
68	TR4	Num	8	506	4: Self inflicted
69	TR5	Num	8	514	5: Off duty
70	TR6	Num	8	522	6: Schemes/exercise
71	TR7	Num	8	530	7: Scheduled training
72	TR8	Num	8	538	On duty
73	TR9	Num	8	546	Unknown on/off duty
74	INJCAT	Num	8	554	
75	INJCAT1	Num	8	562	1: Air transport accident
76	INJCAT2	Num	8	570	2: Land transport accident
77	INJCAT3	Num	8	578	3: Water transport accident
78	INJCAT4	Num	8	586	4: Athletics/sports
79	INJCAT5	Num	8	594	5: Medical complications
80	INJCAT6	Num	8	602	6: Instrumentality of war, enemy
81	INJCAT7	Num	8	610	7: Instrumentality of war, self, accid
82	INJCAT8	Num	8	618	8: Guns, explosives
83	INJCAT9	Num	8	626	9: Machinery/tools
84	INJCAT10	Num	8	634	10: Poison/fire/hot/corrosive
85	INJCAT11	Num	8	642	11: Environmental factor
86	INJCAT12	Num	8	650	12: Fall, misc. or NOS

Q2ANAL5.SD2: Analytic Dataset for Research Question 2: Risk Factors for Knee-Related Hospitalization among Enlisted Personnel in the U.S. Army

Observations: 7211
Variables: 212

Alphabetic listing

Variable	Type	Length	Position	Label	Format	Codes	Values
ADATE	Num	8	527	Date of case admission			
ADMTY1	Num	8	511	Admission for acute, chronic, mixed	AD1TY	1	Acute
						2	Chronic
						3	Mixed
ADMTY2	Num	8	519	Admission for soft tissue, bone or mixed	AD2TY	1	Soft tissue
						2	Bone
						3	Mixed
AGE	Num	8	551	Age at case admit date (years)			
AGEQ	Num	8	622	quintiles of age, 1-2 yr<anyr	AGEQ	1	18-22 yr
						2	23-25 yr
						3	26-29 yr
						4	30-33 yr
						5	34-59 yr
AGEQ1	Num	8	630	18-22 yr	YNNFMT	0	No
						1	Yes
AGEQ2	Num	8	638	23-25 yr	YNNFMT	0	No
						1	Yes
AGEQ3	Num	8	646	26-29 yr	YNNFMT	0	No
						1	Yes
AGEQ4	Num	8	654	30-33 yr	YNNFMT	0	No
						1	Yes
AGEQ5	Num	8	662	34-59 yr	YNNFMT	0	No
						1	Yes
AYR	Num	8	543	Year of case admission			
BASD_J	Num	4	39	Basic Active Service Date			
BLACK	Num	8	875	Black from RACE	YNNFMT	0	No
						1	Yes
CCID	Num	8	567	Case ID			
CC_C	Char	1	165	8996: Complic/comorbid (CC) indicator	YNFMT	N	No
						Y	Yes
CC_H	Char	1	166	8996: Complic/comorbid (CH) indicator		N	No
						Y	Yes
CLIMB	Num	8	1475	Climbing height		0	None
						1	3 feet
						2	9 feet
						3	10 feet
						4	11 feet
						5	30 feet
						6	40 feet
						7	50 feet

Variable	Type	Length	Position	Label	Format	Codes	Values
CLIMB1	Num	8	1483	None	YNNFMT	0	No
						1	Yes
CLIMB2	Num	8	1491	3 feet	YNNFMT	0	No
						1	Yes
CLIMB3	Num	8	1499	9 feet	YNNFMT	0	No
						1	Yes
CLIMB4	Num	8	1507	10 feet	YNNFMT	0	No
						1	Yes
CLIMB5	Num	8	1515	11 feet	YNNFMT	0	No
						1	Yes
CLIMB6	Num	8	1523	30 feet	YNNFMT	0	No
						1	Yes
CLIMB7	Num	8	1531	40 feet	YNNFMT	0	No
						1	Yes
CLIMB8	Num	8	1539	50 feet	YNNFMT	0	No
						1	Yes
CMF0	Num	8	1275	Infantry/gun crews	YNNFMT	0	No
						1	Yes
CMF1	Num	8	1043	Elec equip repair	YNNFMT	0	No
						1	Yes
CMF2	Num	8	1051	Commun/intelli	YNNFMT	0	No
						1	Yes
CMF3	Num	8	1059	Healthcare	YNNFMT	0	No
						1	Yes
CMF4	Num	8	1067	Technical/allied spec	YNNFMT	0	No
						1	Yes
CMF5	Num	8	1075	Support/admin	YNNFMT	0	No
						1	Yes
CMF6	Num	8	1083	Elec/mech equip rep	YNNFMT	0	No
						1	Yes
CMF7	Num	8	1091	Craftsworkers	YNNFMT	0	No
						1	Yes
CMF8	Num	8	1099	Service/supply	YNNFMT	0	No
						1	Yes
CMF9	Num	8	1107	Non-occupational	YNNFMT	0	No
						1	Yes
DATEOUT	Num	4	578	Date of separation-julian			
DATE_D	Char	6	53	Date of dispostion			
DDTE	Num	8	606	Date of disposition-sas			

Variable	Type	Length	Position	Label	Format	Codes	Values
DEGPR2	Num	8	1299	Number of dependents grouped	DEPGRP2	1	None
						2	One
						3	Two
						4	Three+
DEM1	Num	8	1363	Light demand	YNNFMT	0	No
						1	Yes
DEM2	Num	8	1371	Medium demand	YNNFMT	0	No
						1	Yes
DEM3	Num	8	1379	Mod heavy demand	YNNFMT	0	No
						1	Yes
DEM4	Num	8	1387	Heavy demand	YNNFMT	0	No
						1	Yes
DEM5	Num	8	1395	Very heavy demand	YNNFMT	0	No
						1	Yes
DEMAND	Num	8	1355	Physical demand rating			
DEPGR	Num	8	1267	Number of dependents-grouped			
DEPGR0	Num	8	1291	No dependents			
DEPGR1	Num	8	995	One dependent			
DEPGR2	Num	8	1003	Two dependents			
DEPGR3	Num	8	1011	Three + dependents			
DEPGR4	Num	8	1019	Three deps			
DEPGR5	Num	8	1027	Four deps			
DEPGR6	Num	8	1035	Five+ deps			
DEPS	Num	3	21	AM: Number of dependents			
DIAG_2	Char	6	67	Second dx			
DIAG_3	Char	6	73	Third dx			
DIAG_4	Char	6	79	Fourth dx			
DIAG_5	Char	6	85	Fifth dx			
DIAG_6	Char	6	91	Sixth dx			
DIAG_7	Char	6	97	Seventh dx			
DIAG_8	Char	6	103	Eighth dx			
DIAG_P	Char	6	47	Primary diagnosis			
DIST	Num	8	1403	Distance running/walking			
DIST1	Num	8	1411	None			
DIST2	Num	8	1419	1-25 feet			
DIST3	Num	8	1427	26-50 feet			
DIST4	Num	8	1435	51-100 feet			
DIST5	Num	8	1443	101-500 feet			
DIST6	Num	8	1451	0.25-1 mile			
DIST7	Num	8	1459	3 miles			
DIST8	Num	8	1467	25 miles			
DOB_J	Num	4	11	AM: Date of Birth-SAS			
DOE_J	Num	4	43	AM: Date of Entry-SAS			
DSPO	Char	2	59	Disposition			
DTE_IN	Num	8	582	Earliest date of entry to Army			
DX1	Num	8	183	Knee dx position 1?			
DX2	Num	8	191	Knee dx position 2?			
DX3	Num	8	199	Knee dx position 3?			
DX4	Num	8	207	Knee dx position 4?			
DX5	Num	8	215	Knee dx position 5?			

Variable	Type	Length	Position	Label	Format	Codes	Values
DX6	Num	8	223	Knee dx position 6?			
DX7	Num	8	231	Knee dx position 7?			
DX8	Num	8	239	Knee dx position 8?			
EDGR1	Num	8	891	Education at entry, grouped			
EDGR2	Num	8	899	Education at end of follow-up, grouped			
EDGR11	Num	8	907	<=4 yr HS, entry			
EDGR12	Num	8	915	HS or GED, entry			
EDGR13	Num	8	923	>=1 yr coll, entry			
EDGR14	Num	8	931	Alt cred/unk, entry			
EDGR21	Num	8	939	<=4 yr HS, f-up			
EDGR22	Num	8	947	HS or GED, f-up			
EDGR23	Num	8	955	>=1 yr coll, f-up			
EDGR24	Num	8	963	Alt cred/unk, f-up			
ENLIST2	Char	5	859	Enlisted career management group	$ENLIST.		
GRADE	Char	2	61	Pay grade			
GRGRP	Num	8	718	Pay grade, grouped			
GRGRP1	Num	8	726	E1-E3			
GRGRP2	Num	8	734	E4-E6			
GRGRP3	Num	8	742	E7-E9			
HT	Num	3	33	AM: Height			
HYEC	Num	3	8	AM: Education level			
HYEE	Num	3	30	AM: Highest Year of Education at Entry			
ID	Num	8	0	ID Number			
INJCAT	Num	8	758	Injury category			
INJTY11	Num	8	383	Acute vs. chronic , dx1			
INJTY12	Num	8	391	Acute vs. chronic , dx2			
INJTY13	Num	8	399	Acute vs. chronic , dx3			
INJTY14	Num	8	407	Acute vs. chronic , dx4			
INJTY15	Num	8	415	Acute vs. chronic , dx5			
INJTY16	Num	8	423	Acute vs. chronic , dx6			
INJTY17	Num	8	431	Acute vs. chronic , dx7			
INJTY18	Num	8	439	Acute vs. chronic , dx8			
INJTY21	Num	8	447	Soft vs hard tissue, dx1			
INJTY22	Num	8	455	Soft vs hard tissue, dx2			
INJTY23	Num	8	463	Soft vs hard tissue, dx3			
INJTY24	Num	8	471	Soft vs hard tissue, dx4			
INJTY25	Num	8	479	Soft vs hard tissue, dx5			
INJTY26	Num	8	487	Soft vs hard tissue, dx6			
INJTY27	Num	8	495	Soft vs hard tissue, dx7			
INJTY28	Num	8	503	Soft vs hard tissue, dx8			
INJURY	Char	3	64	External cause of injury			
JOB	Char	3	575	PMOS at end of followup			
KDX_N	Num	8	535	Count knee diagnoses per admission			
KNEEHSP	Num	8	175	Knee admission:any proced or diag			
KNEEL	Num	8	830	Kneeling			
KNEEL1	Num	8	1123	None			
KNEEL2	Num	8	1131	Prolonged			
KNEEL3	Num	8	1139	While shoveling, lifting			
KNEEL4	Num	8	1147	While filing			
KPROC_N	Num	8	375	Count knee procedures per admission			
LIFT	Num	8	814	Lifting			
LIFT1	Num	8	1155	None			
LIFT2	Num	8	1163	1-25 lbs			
LIFT3	Num	8	1171	26-50 lbs			
LIFT4	Num	8	1179	51-75 lbs			

Variable	Type	Length	Position	Label	Format	Codes	Values
LIFT5	Num	8	1187	76-100 lbs			
LIFT6	Num	8	1195	101-125 lbs			
LIFT7	Num	8	1203	126-150 lbs			
LIFT8	Num	8	1211	151-175 lbs			
LIFT9	Num	8	1219	Raises 267 lbs			
LIFTA	Num	8	1307	Lift/carry, grouped			
LIFTA0	Num	8	1547	None			
LIFTA1	Num	8	1315	1-50 lbs			
LIFTA2	Num	8	1323	51-100 lbs			
LIFTA3	Num	8	1331	101-150 lbs			
LIFTA4	Num	8	1339	151-175 lbs			
LIFTA5	Num	8	1347	Raise 267 lbs			
LOS	Num	8	614	Length of hospital stay			
LOSQ	Num	8	766	quintiles of length of stay			
LOSQ1	Num	8	774	0-2 days			
LOSQ2	Num	8	782	3-4 days			
LOSQ3	Num	8	790	5-10 days			
LOSQ4	Num	8	798	11-31 days			
LOSQ5	Num	8	806	32=801 days			
MS	Num	3	18	AM: Marital status			
MS1	Num	8	971	Single			
MS2	Num	8	979	Marital status			
MS3	Num	8	987	No longer married			
MS_DEP	Num	3	864	AM: Marital status/dependent			
NEWDEP	Num	8	1283	Dependents (4 gr)			
NONWHITE	Num	8	750	Nonwhite			
P1	Num	8	247	Knee proc position 1?			
P2	Num	8	255	Knee proc position 2?			
P3	Num	8	263	Knee proc position 3?			
P4	Num	8	271	Knee proc position 4?			
P5	Num	8	279	Knee proc position 5?			
P6	Num	8	287	Knee proc position 6?			
P7	Num	8	295	Knee proc position 7?			
P8	Num	8	303	Knee proc position 8?			
PER_SEX	Num	3	27	AM: Sex			
PROC_2	Char	7	116	Second procedure			
PROC_3	Char	7	123	Third procedure			
PROC_4	Char	7	130	Fourth procedure			
PROC_5	Char	7	137	Fifth procedure			
PROC_6	Char	7	144	Sixth procedure			
PROC_7	Char	7	151	Seventh procedure			
PROC_8	Char	7	158	Eighth procedure			
PROC_P	Char	7	109	Principal procedure			
PTY1	Num	8	311				
PTY2	Num	8	319				
PTY3	Num	8	327				
PTY4	Num	8	335				
PTY5	Num	8	343				
PTY6	Num	8	351				
PTY7	Num	8	359				
PTY8	Num	8	367				
PUPULL1	Num	8	1227	None			
PUPULL2	Num	8	1235	<130 lbs			
PUPULL3	Num	8	1243	>=130 lbs			
PUPULL4	Num	8	1251	ft/lb force			
PUPULL5	Num	8	1259	Uses wrench			

Variable	Type	Length	Position	Label	Format	Codes	Values
PUSHPULL	Num	8	822	Push/pull			
RACE	Num	3	15	AM: Race			
RACE_O	Num	8	883	Other from RACE			
RETHNIC	Num	3	24	AM: Race ethnic			
SIT	Num	8	838	sit			
STAND	Num	8	846	Stand			
SURG	Num	8	167	Any knee procedure?			
SVC	Num	8	559	Duration svc at case admit date (months)			
SVCQ	Num	8	670	quintiles of durn svc, 1-2 yr<anyr			
SVCQ1	Num	8	678	0-2 yr			
SVCQ2	Num	8	686	3-4 yr			
SVCQ3	Num	8	694	5-7 yr			
SVCQ4	Num	8	702	8-12 yr			
SVCQ5	Num	8	710	13-34 yr			
TRAUMA	Char	1	63	Trauma code			
WHITE	Num	8	867	White from RACE			
WT	Num	3	36	AM: Weight			
YR_IN	Num	8	590	Year of entry to Army			
YR_OUT	Num	8	598	Year of separation. If none, set to 9999			

Listing by position

#	Variable	Type	Len	Pos
1	ID	Num	8	0
2	HYEC	Num	3	8
3	DOB_J	Num	4	11
4	RACE	Num	3	15
5	MS	Num	3	18
6	DEPS	Num	3	21
7	RETHNIC	Num	3	24
8	PER_SEX	Num	3	27
9	HYEE	Num	3	30
10	HT	Num	3	33
11	WT	Num	3	36
12	BASD_J	Num	4	39
13	DOE_J	Num	4	43
14	DIAG_P	Char	6	47
15	DATE_D	Char	6	53
16	DSPO	Char	2	59
17	GRADE	Char	2	61
18	TRAUMA	Char	1	63
19	INJURY	Char	3	64
20	DIAG_2	Char	6	67
21	DIAG_3	Char	6	73
22	DIAG_4	Char	6	79
23	DIAG_5	Char	6	85
24	DIAG_6	Char	6	91
25	DIAG_7	Char	6	97
26	DIAG_8	Char	6	103
27	PROC_P	Char	7	109
28	PROC_2	Char	7	116
29	PROC_3	Char	7	123
30	PROC_4	Char	7	130
31	PROC_5	Char	7	137
32	PROC_6	Char	7	144
33	PROC_7	Char	7	151
34	PROC_8	Char	7	158

#	Variable	Type	Len	Pos
35	CC_C	Char	1	165
36	CC_H	Char	1	166
37	SURG	Num	8	167
38	KNEEHSP	Num	8	175
39	DX1	Num	8	183
40	DX2	Num	8	191
41	DX3	Num	8	199
42	DX4	Num	8	207
43	DX5	Num	8	215
44	DX6	Num	8	223
45	DX7	Num	8	231
46	DX8	Num	8	239
47	P1	Num	8	247
48	P2	Num	8	255
49	P3	Num	8	263
50	P4	Num	8	271
51	P5	Num	8	279
52	P6	Num	8	287
53	P7	Num	8	295
54	P8	Num	8	303
55	PTY1	Num	8	311
56	PTY2	Num	8	319
57	PTY3	Num	8	327
58	PTY4	Num	8	335
59	PTY5	Num	8	343
60	PTY6	Num	8	351
61	PTY7	Num	8	359
62	PTY8	Num	8	367
63	KPROC_N	Num	8	375
64	INJTY11	Num	8	383
65	INJTY12	Num	8	391
66	INJTY13	Num	8	399
67	INJTY14	Num	8	407
68	INJTY15	Num	8	415
69	INJTY16	Num	8	423
70	INJTY17	Num	8	431
71	INJTY18	Num	8	439
72	INJTY21	Num	8	447
73	INJTY22	Num	8	455
74	INJTY23	Num	8	463
75	INJTY24	Num	8	471
76	INJTY25	Num	8	479
77	INJTY26	Num	8	487
78	INJTY27	Num	8	495
79	INJTY28	Num	8	503
80	ADMTY1	Num	8	511
81	ADMTY2	Num	8	519
82	ADATE	Num	8	527
83	KDX_N	Num	8	535
84	AYR	Num	8	543
85	AGE	Num	8	551
86	SVC	Num	8	559
87	CCID	Num	8	567
88	JOB	Char	3	575
89	DATEOUT	Num	4	578
90	DTE_IN	Num	8	582
91	YR_IN	Num	8	590
92	YR_OUT	Num	8	598

#	Variable	Type	Len		Pos
93	DDTE	Num		8	606
94	LOS	Num		8	614
95	AGEQ	Num		8	622
96	AGEQ1	1=None	1=None		630
97	AGEQ2	Num		8	638
98	AGEQ3	Num		8	646
99	AGEQ4	Num		8	654
100	AGEQ5	Num		8	662
101	SVCQ	Num		8	670
102	SVCQ1	Num		8	678
103	SVCQ2	Num		8	686
104	SVCQ3	Num		8	694
105	SVCQ4	Num		8	702
106	SVCQ5	Num		8	710
107	GRGRP	Num		8	718
108	GRGRP1	Num		8	726
109	GRGRP2	Num		8	734
110	GRGRP3	Num		8	742
111	NONWHITE	Num		8	750
112	INJCAT	Num		8	758
113	LOSQ	Num		8	766
114	LOSQ1	Num		8	774
115	LOSQ2	Num		8	782
116	LOSQ3	Num		8	790
117	LOSQ4	Num		8	798
118	LOSQ5	Num		8	806
119	LIFT	Num		8	814
120	PUSHPULL	Num		8	822
121	KNEEL	Num		8	830
122	SIT	Num		8	838
123	STAND	Num		8	846
124	ENLIST	Char		5	854
125	ENLIST2	Char		5	859
126	MS_DEP	Num		3	864
127	WHITE	Num		8	867
128	BLACK	Num		8	875
129	RACE_O	Num		8	883
130	EDGR1	Num		8	891
131	EDGR2	Num		8	899
132	EDGR11	Num		8	907
133	EDGR12	Num		8	915
134	EDGR13	Num		8	923
135	EDGR14	Num		8	931
136	EDGR21	Num		8	939
137	EDGR22	Num		8	947
138	EDGR23	Num		8	955
139	EDGR24	Num	1=None		963
140	MS1	Num		8	971
141	MS2	Num		8	979
142	MS3	Num		8	987
143	DEPGR1	Num		8	995
144	DEPGR2	Num		8	1003
145	DEPGR3	Num		8	1011
146	DEPGR4	Num		8	1019
147	DEPGR5	Num		8	1027
148	DEPGR6	Num		8	1035
149	CMF1	Num		8	1043
150	CMF2	Num		8	1051

#	Variable	Type	Len	Pos
151	CMF3	Num	8	1059
152	CMF4	Num	8	1067
153	CMF5	Num	8	1075
154	CMF6	Num	8	1083
155	CMF7	Num	8	1091
156	CMF8	Num	8	1099
157	CMF9	Num	8	1107
158	CMF10	Num	8	1115
159	KNEEL1	Num	8	1123
160	KNEEL2	Num	1=None	1131
161	KNEEL3	Num	8	1139
162	KNEEL4	Num	8	1147
163	LIFT1	Num	8	1155
164	LIFT2	Num	8	1163
165	LIFT3	Num	8	1171
166	LIFT4	Num	8	1179
167	LIFT5	Num	8	1187
168	LIFT6	Num	8	1195
169	LIFT7	Num	8	1203
170	LIFT8	Num	8	1211
171	LIFT9	Num	8	1219
172	PUPULL1	Num	8	1227
173	PUPULL2	Num	8	1235
174	PUPULL3	Num	8	1243
175	PUPULL4	Num	8	1251