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Complete List of Authors:	Nelson, D. Alan; Stanford University School of Medicine, Department of Medicine Kaplan, Robert ; Stanford University School of Medicine Weisman, Michael M; Stanford University School of Medicine, Department of Medicine Kurina, Lianne; Stanford University School of Medicine, Department of Medicine
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Service Discharges Among US Army Personnel with Rheumatic Disease Conditions

D. Alan Nelson;[1] Robert M. Kaplan, PhD;[2] Michael H. Weisman, MD;[3] Lianne M. Kurina, PhD[1]

Affiliations

1. Department of Medicine, Division of Primary Care and Population Health, Stanford University School of Medicine, Stanford CA, USA

2. Clinical Excellence Research Center, Stanford University School of Medicine, Stanford CA, USA

3. Department of Medicine, Division of Rheumatology, Stanford University School of Medicine, Department of Medicine, Division of Rheumatology

Corresponding author: Lianne Kurina, 450 Jane Stanford Way, Building 20, Stanford University, Stanford CA 94305-2160; lkurina@stanford.edu

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ABSTRACT

Objectives: To determine the probability of discharge from military service among soldiers following an incident diagnosis of ankylosing spondylitis (AS), rheumatoid arthritis (RA), psoriasis (Ps) or systemic lupus erythematous (SLE).

Methods: All soldiers on active-duty in the U.S. Army between January 2014 and June 2017 were included in a retrospective cohort analysis. Termination from service was ascertained using personnel records. Diagnostic codes were used to identify incident cases of the four rheumatic diseases and, for comparison, diabetes mellitus (DM). Time to discharge was modeled using sex stratified multivariate survival analysis.

Results: The analysis included 657,417 individuals with a total of 1.2-million-person years of observation. An elevated risk of discharge was observed in association with each of the five chronic conditions studied. The increase in adjusted risk of discharge was highest among soldiers with AS (male HR = 2.5, 95% CI 2.1, 3.0; female HR = 2.1, 95% CI 1.4, 3.2) and with DM (male HR = 2.4, 95% CI 2.2, 2.7; female HR = 2.2, 95% CI 1.8, 2.5), followed by those with RA (male HR = 1.8, 95% CI 1.5, 2.2; female HR = 1.8, 95% CI 1.4, 2.4).

Conclusions: Military discharges are consequential for the service and the servicemember. The doubling in risk of discharge for those with AS or RA was comparable to that for personnel with diabetes mellitus. Conditions that affect the spine and peripheral joints may often incompatible with military readiness. Nevertheless, a substantial fraction of servicemembers with these diagnoses continued in service.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- Very little is known about the military trajectories of those developing rheumatic conditions.
- Utilizing the total active-duty US Army population from 2014-17, we found a doubling of the likelihood of leaving military service following a diagnosis of ankylosing spondylitis and rheumatoid arthritis.
- Conditions impacting the spine and peripheral joints may present challenges but do not appear invariably incompatible with continued military service.
- Our results cannot necessarily be generalized to other US military branches or to servicemembers of other nations.

INTRODUCTION

Rheumatic disease (sometimes referred to as "auto-immune") conditions may pose important challenges for military personnel. In many cases, affected individuals could be unable to carry out their military duties and would thus be given a medical discharge. Given the operational and economic costs of discharges, as well as the human impact on the soldier from the onset of a chronic disease, it is critical to better understand typical career trajectories in the military following onset of rheumatic diseases.[1]

Although military clinicians are provided substantial guidance with respect to both diagnosing and managing rheumatic disorders[2], we were unable to identify prior research specifically addressing the risk of military service terminations associated with rheumatic disease diagnoses. Insufficient evidence could potentially lead to either hastening service discharges for those still ably serving under effective management, or supporting a delayed action that could permit disease progression associated with a subsequent service discharge.[3] Thus, determining the current risk of military discharge, if any, associated with such conditions is important for the military mission as well as for clinicians and patients alike.

In this study, our objective was to characterize the associations between a selection of commonly encountered chronic rheumatic conditions, including ankylosing spondylitis, rheumatoid arthritis, psoriasis and systemic lupus erythematosus, and discharge from service among active-duty service members, adjusting for a range of demographic, health-related, and military-specific characteristics. For comparison, we also analyzed the risk of discharge following diagnosis with diabetes mellitus, which is among the most prevalent chronic diseases in the military population[4].

METHODS

We utilized a longitudinal panel dataset from the Stanford Military Data Repository (SMDR), a de-identified dataset comprising administrative and health-related datasets on the active-duty US Army. The current retrospective cohort analysis is based on person-months of active military service among individuals who served with the US Army between January 2014 and June 2017. Demographic and military service data, including terminations of active-duty service, were obtained from official personnel records provided by the Defense Manpower Data Center (DMDC)[5].

We focused on four chronic rheumatic diseases – ankylosing spondylitis (AS), rheumatoid arthritis (RA), psoriasis (Ps), and systemic lupus erythematosus (SLE) and used a commonly encountered metabolic condition, diabetes mellitus (DM), for comparison purposes.

To identify incident diagnoses of AS, RA, Ps, SLE, or DM (either Type 1 or 2), we employed two approaches. First, we used clinical data from the Military Health System Data Repository, which includes records of out- and inpatient care provided to US service members in military as well as civilian facilities. For encounters occurring between January 2014 and October 2015, conditions were identified using International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) data. ICD-10 codes were used for encounters occurring between November 2015 and June 2017. For each condition, the ICD-9-CM and ICD-10 diagnosis codes were, respectively: AS, 720.0 and M45.x; RA, 714.x and M05.x, M06.x; Ps, 696.x and L40.x; SLE, 710.0 and M32.1x, M32.9x; and DM, 250.x and E.08.x – E.11.x, E13.x.

The second source for identifying incident cases was "eProfile", the official system of record in which soldiers' duty restrictions and the clinical diagnoses warranting them are

archived. A free-text search algorithm was used to filter clinician entries of the selected medical conditions; the accuracy of captured diagnoses was then confirmed with a visual review.

Subjects who began their military service during the observed time period were examined for incident diagnoses beginning at the outset of their service. Military enlistment policies require initial screening examinations. Any of the five conditions considered in this study (AS, RA, Ps, SLE, and DM) normally disqualify an individual from induction into service (AR 40-501). All new soldiers in the dataset were therefore presumed to be free of known diagnoses of these conditions when they entered service.

The remaining individuals entered service at a wide variety of times prior to January 2014, and could, therefore, have been diagnosed with one or more of these conditions before our study period. Thus, for those soldiers enlisting prior to January 2014, we applied a "wash-out" or "run-in" period in which at least 12 initial months of observation were required to rule out follow-up care for previously diagnosed conditions in their health records and duty restrictions. This time period was chosen because each member is required to undergo an annual Periodic Health Assessment, a health screening[6] in which major medical problems are typically identified. Observation for incident conditions thus began in January 2015 among those entering service prior to January 2014.

Dependent variable

The primary outcome variable was a discharge from service for any reason. The discharge information was identified from the DMDC personnel records.

Independent variables

We included a wide range of independent variables to minimize possible confounding of the associations between the selected disorders and service discharges. Independent variables whose values varied with time were continuously updated in each subject's longitudinal data.

The covariates included sex, age, race, marital status, statement of tobacco use at a prior health encounter, military pay grade, and active-duty service time. We categorized the two quantitative variables. For age, we divided individuals in approximate quartiles on the basis of age. For active-duty service time, we categorized in such a way as to capture typical career eras for soldiers. Specifically, we employed a category for <4 years to capture those in their first term of service and a 4-10 year category for people in the decision window before choosing whether to remain in service until retirement. We then divided the remaining group, who are composed largely of people remaining in service until retirement into two groups: >10-16 and >16 years.

In addition, we created a dichotomous variable to capture whether each member held a combat-focused occupation versus a job description functioning in a support role. We also included an additional categorical variable to account for the type of military unit in which the subject served to adjust for any related systematic difference in exposures. The categories were: combat deployable units; those involved in training and administrative functions; special operations forces; medical units; and all other or unknown unit types.

Patient and public involvement

Study participants were not involved in the design, recruitment, or conduct of the study, as this was a retrospective analysis of passively collected data on military service members. All service members will be able to view the study results upon publication of the paper.

Statistical analysis

To provide a descriptive overview of the study population, we examined subjects at the last-available, person-specific monthly observation, stratifying on presence or absence of service discharge. We tested for differences in categorical variable distributions using chi square tests and applied two-sided t-tests for continuous variables.

To estimate adjusted associations between the selected conditions and service discharge, we computed multivariable survival models. The models used the Weibull distribution to estimate adjusted hazard ratios for service discharge. Because of possible differences between males and females in the rates of the conditions being studied and in rates of separation of the Army, the unadjusted and adjusted analyses were sex-stratified.

All analyses were conducted using Stata statistical software version 14.2 (StataCorp, College Station, Texas). We considered p-values ≤ 0.05 to be statistically significant. The study was approved by the institutional review board at Stanford University (Protocol 31161) and also underwent secondary review by the human research protections office of the Defense Health Agency.

RESULTS

The analysis included 657,417 eligible subjects who were observed for a total of 1.2 million person-years of time at risk for the regression models. On average, each subject was observed for 1.8 years (median: 2.4; standard deviation [SD]: 0.9).

Table 1. Rheumatic disease percentages in the U.S. Army study population, 2014-7 (N = 657,417), stratified by sex and military discharge status, as of the last person-specific observation. Values represent numbers (percentages) and p-values are derived from of chi square tests comparing factor distributions.

Factor	Males; n = 560,243 (85.2)		Females; n = 97,174 (14.8)	
	No discharge 386,436 (69.0)	Discharged 173,807 (31.0)	No discharge 66,833 (68.8)	Discharged 30,341 (31.2)
Ankylosing spondylitis				
Yes	146 (55.3)	118 (44.7)	33 (56.9)	25 (43.1)
No	386,290 (69.0)	173,689 (31.0)	66,800 (68.8)	30,316 (31.2)
	$P < 0.001$		$P = 0.051$	
Rheumatoid arthritis				
Yes	303 (62.1)	185 (37.9)	153 (62.2)	93 (37.8)
No	386,133 (69.0)	173,622 (31.0)	66,680 (68.8)	30,248 (31.2)
	$P = 0.001$		$P = 0.026$	
Psoriasis				
Yes	1534 (69.8)	664 (30.2)	314 (68.3)	146 (31.7)
No	384,902 (69.0)	173,143 (31.0)	66,519 (68.8)	30,195 (31.2)
	$P = 0.408$		$P = 0.811$	

Systemic lupus erythematosus				
Yes	59 (62.8)	35 (37.2)	95 (66.9)	47 (33.1)
No	386,377 (69.0)	173,772 (31.0)	66,738 (68.8)	30,294 (31.2)
	$P = 0.193$		$P = 0.629$	
Diabetes mellitus				
Yes	1175 (55.5)	942 (44.5)	259 (61.1)	165 (38.9)
No	385,261 (69.0)	172,865 (31.0)	66,574 (68.8)	30,176 (31.2)
	$P < 0.001$		$P = 0.001$	

The unadjusted results are presented in Table 1. Overall, 31.0% of males and 31.2% of females without the conditions of interest were discharged during the follow-up time. A significantly higher proportion of those with a diagnosis of AS, RA and DM were discharged. AS patients were most likely to be discharged, with 44.7% of males and 43.1% of females discharged. Among the RA patients, 37.9% of the males and 37.8% of the females were discharged. Among those with DM, 44.5% of the males and 38.9% of the females were discharged. No significant difference in the unadjusted probability of discharge was observed in association with either Ps or SLE. Men and women with psoriasis experienced the lowest discharge rates of those with the selected conditions, respectively involving 30.2% and 31.7% of subjects with this diagnostic history.

Table 2. Characteristics of the U.S. Army study population, 2014-7 (N = 657,417) as of the last person-specific observation, stratified by sex and military discharge. Values represent numbers (percentages) unless otherwise noted.

Factor	Males; n = 560,243 (85.2)		Females; n = 97,174 (14.8)	
	No discharge 386,436 (69.0)	Discharged 173,807 (31.0)	No discharge 66,833 (68.8)	Discharged 30,341 (31.2)
Age, years	$P < 0.001^{A}$		$P < 0.001^{A}$	
≤ 22	98,351 (69.1)	43,912 (30.9)	17,941 (64.8)	9754 (35.2)
23 to 27	102,712 (66.1)	52,620 (33.9)	18,487 (68.3)	8591 (31.7)
28 to 35	101,863 (72.0)	39,570 (28.0)	17,733 (72.8)	6621 (27.2)
≥ 36	83,510 (68.9)	37,705 (31.1)	12,672 (70.2)	5375 (29.8)
Mean [median, standard deviation]	$P = 1.00^{B}$		$P < 0.001^{B}$	
	29.0 [27, 8.1]	29.0 [26, 8.6]	28.5 [27, 7.9]	27.9 [26, 8.6]
Race	$P < 0.001^{A}$		$P < 0.001^{A}$	
White	269,731 (68.2)	126,022 (31.8)	32,726 (66.8)	16,256 (33.2)
Black	75,041 (69.5)	32,972 (30.5)	24,364 (69.1)	10,899 (30.9)
Asian or Pacific Islander	22,021 (75.0)	7322 (25.0)	5112 (76.0)	1612 (24.0)
Native American or Alaskan	2711 (66.2)	1381 (33.8)	616 (62.9)	364 (37.1)

Multiracial, other or unspecified	16,932 (73.5)	6110 (26.5)	4015 (76.8)	1210 (23.2)
Marital status	$P < 0.001^{A}$		$P = 0.001^{A}$	
Married	222,598 (70.3)	94,033 (29.7)	32,376 (69.3)	14,350 (30.7)
Never married	148,065 (67.6)	70,942 (32.4)	26,584 (68.5)	12,243 (31.5)
Formerly married	15,773 (64.1)	8832 (35.9)	7873 (67.8)	3748 (32.2)
Military pay grade	$P < 0.001^{A}$		$P = 0.001^{A}$	
≤ E-4	170,482 (62.9)	100,574 (37.1)	30,841 (61.5)	19,310 (38.5)
E-5 & E-6	101,670 (72.5)	38,602 (27.5)	15,433 (74.8)	5200 (25.2)
E-7 to E-9	41,859 (74.1)	14,635 (25.9)	5464 (75.2)	1801 (24.8)
W-1 to O-3	48,957 (78.6)	13,346 (21.4)	10,544 (79.1)	2793 (20.9)
≥ O-4	23,468 (77.9)	6650 (22.1)	4551 (78.6)	1237 (21.4)
Active military service time, years	$P < 0.001^{A}$		$P < 0.001^{A}$	
< 4	168,536 (68.8)	76,450 (31.2)	32,520 (67.7)	15,502 (32.3)
> 4 to 10	102,350 (66.4)	51,694 (33.6)	17,546 (66.6)	8780 (33.4)
> 10 to 16	59,802 (77.2)	17,675 (22.8)	9063 (78.6)	2466 (21.4)
> 16	55,748 (66.6)	27,988 (33.4)	7704 (68.2)	3593 (31.8)
Mean [median, standard deviation]	$P < 0.001^{B}$		$P < 0.001^{B}$	
	7.5 [4.9, 6.9]	7.8 [4.9, 7.4]	6.6 [4.2, 6.4]	6.4 [3.9, 6.9]

Held a combat-focused occupation	$P < 0.001^{A}$		$P = 0.255^{A}$	
No	245,696 (70.5)	102,832 (29.5)	63,017 (68.7)	28,704 (31.3)
Yes	140,740 (66.5)	70,975 (33.5)	3726 (69.5)	1637 (30.5)
Military unit type	$P < 0.001^{A}$		$P < 0.001^{A}$	
Combat-deployable, conventional	182,518 (66.0)	94,133 (34.0)	28,819 (68.4)	13,291 (31.6)
Training-related or administrative	68,369 (67.5)	32,949 (32.5)	11,832 (59.4)	8097 (40.6)
Special operations	28,852 (82.2)	6249 (17.8)	1567 (83.2)	317 (16.8)
Medical	15,894 (65.4)	8402 (34.6)	8794 (70.6)	3654 (29.4)
Other or uncertain	90,803 (73.9)	32,074 (26.1)	15,821 (76.0)	4982 (24.0)
Self-reported tobacco use	$P < 0.001^{A}$		$P < 0.001^{A}$	
No	229,160 (71.3)	92,056 (28.7)	52,010 (69.8)	22,503 (30.2)
Yes	157,276 (65.8)	81,751 (34.2)	14,823 (65.4)	7838 (34.6)

Notes:

A. Results of chi square tests.

B. Results of two-sided t-tests.

Unadjusted discharge rates varied significantly by the demographic factors of age, race, marital status as well as by military occupational characteristics (Table 2). Males in combat-focused professions were at the highest unadjusted probability of discharge (33.5% of these men; $P < 0.001$), whereas no association was observed between occupation and discharge among females. Crude associations between military unit type and discharge also varied by sex. Males in medical units had the highest proportion of those discharged (34.6%); among females, those in training and administrative units were most likely to be discharged (40.6%). Tobacco users were also significantly more likely to be discharged than non-users in both sexes.

Table 3. Adjusted hazard ratios (aHRs) from sex-stratified multivariable Weibull regression models for military service discharge (N = 657,417). Models adjusted for all listed variables.

Factor	Males; n = 560,243		Females; n = 97,174	
	aHR[1]	95% confidence interval	aHR[1]	95% confidence interval
Had ankylosing spondylitis	2.5***	2.1 – 3.0	2.1***	1.4 – 3.2
Had rheumatoid arthritis	1.8***	1.5 – 2.2	1.8***	1.4 – 2.4
Had psoriasis	1.4***	1.3 – 1.5	1.4***	1.2 – 1.7
Had systemic lupus erythematosus	1.7**	1.2 – 2.3	1.5*	1.0 – 2.1
Had diabetes mellitus	2.4***	2.2 – 2.7	2.2***	1.8 – 2.5

Age, years (referent: ≤ 22)				
23 to 27	1.3**	1.1 – 1.5	0.9	0.8 – 1.1
28 to 35	1.4***	1.2 – 1.6	1.0	0.8 – 1.2
≥ 36	1.7***	1.5 – 2.0	1.2	1.0 – 1.4
Race (referent: Asian or Pacific Islander)				
White	1.3***	1.3 – 1.4	1.5***	1.4 – 1.6
Black	1.2***	1.2 – 1.2	1.2***	1.1 – 1.3
Native American or Alaskan	1.3***	1.2 – 1.5	1.5***	1.3 – 1.7
Multiracial, other or unspecified	1.2***	1.1 – 1.2	1.1*	1.0 – 1.2
Marital status (referent: married)				
Never married	1.2***	1.2 – 1.2	0.9*	0.8 – 1.0
Formerly married	1.3***	1.2 – 1.3	1.1***	1.0 – 1.1
Military pay grade (referent: ≥ O-4)				
≤ E-4	6.6***	5.7 – 7.6	5.4***	4.7 – 6.1
E-5 & E-6	2.0***	1.8 – 2.2	1.8***	1.5 – 2.0
E-7 to E-9	1.2**	1.1 – 1.3	1.1	0.9 – 1.2
W-1 to O-3	1.6***	1.4 – 1.7	1.4***	1.3 – 1.6
Active military service time, years (referent: < 4)				
> 4 to 10	2.1***	1.9 – 2.2	2.1***	1.9 – 2.2

> 10 to 16	1.9***	1.8 – 2.1	1.7***	1.5 – 2.0
> 16	3.8***	3.4 – 4.2	3.5***	3.0 – 3.9
Held a combat-focused occupation	1.2***	1.1 – 1.4	1.2*	1.0 – 1.4
Military unit type (referent: special operations)				
Combat-deployable, conventional	1.9***	1.8 – 2.0	1.7***	1.4 – 2.0
Training-related or administrative	2.2***	1.8 – 2.8	2.8***	1.9 – 4.0
Medical	2.3***	1.9 – 2.7	1.7***	1.4 – 2.1
Other or uncertain	1.4***	1.2 – 1.7	1.2	1.0 – 1.6
Self-reported tobacco use	1.4***	1.3 – 1.5	1.3***	1.2 – 1.3

1. Statistical significance: ***P<0.001; **P<0.01; *P<0.05.

The results of the adjusted models are shown in Table 3. An elevated risk of discharge was observed in association with each of the five chronic conditions studied, relative to soldiers without these conditions during the same time period. The increase in adjusted risk of discharge was highest among soldiers with AS (male HR = 2.5, 95% CI 2.1, 3.0; female HR = 2.1, 95% CI 1.4, 3.2) and with DM (male HR = 2.4, 95% CI 2.2, 2.7; female HR = 2.2, 95% CI 1.8, 2.5), followed by those with RA (male HR = 1.8, 95% CI 1.5, 2.2; female HR = 1.8, 95% CI 1.4, 2.4). For those with Ps, the adjusted hazard of discharge was 40% higher (male HR = 1.4, 95% CI: 1.3, 1.5; female HR = 1.4, 95% CI: 1.2, 1.7). For those with SLE, the adjusted hazard of

discharge was 70% higher among males (HR = 1.7, 95% CI: 1.2, 2.3) and 50% higher among females (HR = 1.5, 95% CI: 1.0, 2.1).

Considering the other predictors, the probability of discharge increased significantly with both age and service time (Table 3). Compared to those in the Asian/Pacific Islander category, individuals in each of the "other" race categories were significantly more likely to be discharged. Relative to those in special operations, hazard of discharge was significantly higher in each of the other types of military units. Finally, those in a combat-focused occupation were slightly but significantly more likely to be discharged than those occupying administrative or support roles.

DISCUSSION

In this large study of the total US Army population between 2014 and 2017, we found that those service members with ankylosing spondylitis and rheumatoid arthritis were approximately twice as likely to be discharged. The increase in risk of military discharge was very similar to those soldiers with the non-rheumatic comparison condition of diabetes mellitus. Significant elevations in the risk of military discharge were observed in association with each of the conditions studied, ranging from 40% increases for soldiers with psoriasis or systemic lupus erythematosus to 150% increases among males or females with ankylosing spondylitis. It is clear that diagnoses of these conditions are strongly associated with a decreased likelihood of remaining on active-duty military service.

The differences in effect sizes for the selected conditions may be related to occupational limitations, the current state of treatment options, and the possibility that military readiness activities might make the condition worse. For example, given the importance of spine health to military service, AS may be the most limiting, regardless of treatment.[7] It could also be more

concerning with respect to the impact of military exposures on disease progression or to the risk of trauma causing spinal fracture. Multiple studies have shown that spinal fractures occur in AS patients at a higher frequency in all ages and disease durations; although most are low impact, many are localized to the cervical spine which in turn could cause serious injury to the spinal cord and result in death[8-14]. Such risks may be elevated in the military, given the physical conditioning and duties required; service members and clinicians may thus act more conservatively when the diagnosis of AS is made.

Similarly, it would be expected that the diagnosis of RA would represent a challenge to military readiness in both male and female soldiers. Rheumatoid arthritis affects the hands, knees, and feet in such a manner that produces pain, stiffness, and diminished mobility with profound effects, in the untreated patient, on locomotion and fine manipulation[15].

We observed a slightly smaller increase in risk of discharge associated with a diagnosis of SLE, which may reflect the heterogeneity of the condition. Patients with SLE may not have visible signs of the disease; at the same time soldiers with SLE may experience minimal effects of the disease on the musculoskeletal system, which may often be easily managed with anti-inflammatory agents. Alternatively, error with regard to the SLE diagnoses may account for the lower rates of service discharge in this group relative to AS or DM. Anti-nuclear antibodies are necessary for the diagnosis of SLE, but it has been shown that the rate of ANA positivity in the general population is increasing in recent years even in the absence of SLE.[16] It is possible that the comparatively lower rate of discharge of subjects with SLE in this study could reflect misclassification of these subjects with a positive ANA as having a bona-fide diagnosis of SLE as opposed to a false positive test in the subject's health record.

We also observed, comparatively, a relatively minimal impact of psoriasis on military discharge rates. In the most recent report of the NHANES population-based survey of psoriasis prevalence in adults in the United States, psoriasis was quite common (3%) and prevalence has remained largely unchanged over the last two decades[17]. However, the majority of patients with a diagnosis of psoriasis had very few symptoms or findings at the time of the survey suggesting that psoriasis was mild in most cases. If the same pattern were to hold for the Army population, this could explain the relatively minimal increase in discharge likelihood in association with a psoriasis diagnosis.

We utilized another chronic disease, diabetes mellitus, as a comparison condition for our study of rheumatic conditions. Interestingly, though not a condition that impacts the musculoskeletal system, we observed very comparable increases in discharge rates in association with diabetes mellitus compared to ankylosing spondylitis. It is possible that the complexities of disease management of this condition pose challenges in the military operational context.

It is clear that the conditions we studied are associated with high rates of medical discharge in the US Army. Such discharges likely reflect basic incompatibilities of some features of these conditions with military readiness in the Army. It should be noted, however, that although discharge rates were elevated following diagnoses, it was by no means universal, with a large fraction of individuals remaining in service following diagnosis for the period of our study. Symptoms for each of the conditions manifest on a spectrum of severity and it is encouraging that many soldiers were able to remain in service despite diagnoses of these chronic medical conditions. It should be noted that this analysis was limited to the Army. It is possible, but not certain, that our results would generalize to the other military branches given commonalities across branches with regard to career-associated physical demands. Further research is needed to

clarify the treatment and disease progression trajectories for the selected conditions, many of whom (including RA and AS) can be managed early and aggressively with modern drugs producing an almost disease-free condition with full activity capabilities.

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DATA AVAILABILITY STATEMENT

The data used in this study were provided via agreements with the Defense Health Agency and with the US Army Office of the Surgeon General. These agreements preclude us from making the data available.

CONTRIBUTORSHIP STATEMENT

All authors contributed to study design, interpretation of the analyses, and to the drafting of the manuscript. DAN and LMK were responsible for procuring and organizing the data. DAN was responsible for running the analyses.

CONFLICT OF INTEREST

The authors have no financial interests or relationships to disclose.

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STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract: See methods section of abstract, p. 2.
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found: See methods and results section of abstract, p. 2.
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported: See paragraphs 1 & 2 of the Introduction, p. 4.
Objectives	3	State specific objectives, including any prespecified hypotheses: See paragraph 3 of the Introduction, p. 4.
Methods		
Study design	4	Present key elements of study design early in the paper: See paragraph 1 of the Methods, p. 5.
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection: See paragraph 1 of the Methods, p. 5.
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up: See Methods section, paragraph 1 (p. 5) and paragraphs 5 & 6, p. 6.
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed: Not applicable (N/A).
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable: See Methods: paragraphs 2 & 3 (p. 5); the Dependent variable section (p. 6) and the Independent variables section (pp. 6-7).
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group: See Methods: paragraph 1 (p. 5); paragraphs 3 & 4 (p. 5); the Dependent variable section (p. 6) and the Independent variables section (pp. 6-7).
Bias	9	Describe any efforts to address potential sources of bias: See Methods, paragraph 6 (p. 6).
Study size	10	Explain how the study size was arrived at: See Methods, paragraphs 5 & 6 (p. 6).
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why: See first paragraph of the Independent variables section of Methods, p. 7.
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding: See the "Statistical analysis" section of the Methods section, pp. 7-8.
		(*b*) Describe any methods used to examine subgroups and interactions: See the second paragraph of the Statistical Analysis section of the Methods section, p. 8.
		(*c*) Explain how missing data were addressed: Not applicable to our study.
		(*d*) If applicable, explain how loss to follow-up was addressed: Not applicable to our study.
		(*e*) Describe any sensitivity analyses: Not applicable to our study.
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study,

		completing follow-up, and analysed: See the first paragraph of the Results, p. 8.
		(b) Give reasons for non-participation at each stage: Not applicable to our study.
		(c) Consider use of a flow diagram: Not applicable to our study.
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders: See Table 1, pp. 9-10 and Table 2, pp. 11-13.
		(b) Indicate number of participants with missing data for each variable of interest: Not applicable to our study.
		(c) Summarise follow-up time (eg, average and total amount): See first paragraph of the Results, p. 8.
Outcome data	15*	Report numbers of outcome events or summary measures over time: See Table 1, pp. 9-10 and the second paragraph of the Results section, p. 10.
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included: See Table 3, pp. 14-16.
		(*b*) Report category boundaries when continuous variables were categorized: See Table 2 (pp. 11-13) and Table 3 (pp 14-16).
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period: Not applicable to our study.
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses: Not applicable to our study.
Discussion		
Key results	18	Summarise key results with reference to study objectives: See first paragraph of the Discussion section, p. 17.
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias: See fourth paragraph of the Discussion section, p. 18.
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence: See Discussion section, pp. 17-20.
Generalisability	21	Discuss the generalisability (external validity) of the study results: See seventh paragraph of the Discussion section, p. 19.
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based: See the Funding section, p. 20.

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

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Service Discharges Among US Army Personnel with Selected Musculoskeletal and Skin Conditions

D. Alan Nelson, PhD;[1] Robert M. Kaplan, PhD;[2] Michael H. Weisman, MD;[3] Lianne M. Kurina, PhD[1]

Affiliations

1. Department of Medicine, Division of Primary Care and Population Health, Stanford University School of Medicine, Stanford CA, USA

2. Clinical Excellence Research Center, Stanford University School of Medicine, Stanford CA, USA

3. Department of Medicine, Division of Rheumatology, Stanford University School of Medicine, Department of Medicine, Division of Rheumatology

Corresponding author: Lianne Kurina, 450 Jane Stanford Way, Building 20, Stanford University, Stanford CA 94305-2160; lkurina@stanford.edu

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ABSTRACT

Objectives: To determine the probability of discharge from military service among soldiers following an incident diagnosis of ankylosing spondylitis (AS), rheumatoid arthritis (RA), psoriasis (Ps) or systemic lupus erythematous (SLE).

Methods: All soldiers on active duty in the U.S. Army between January 2014 and June 2017 were included in a retrospective cohort analysis. Termination from service was ascertained using personnel records. Diagnostic codes were used to identify incident cases of the four musculoskeletal and skin diseases and, for comparison, diabetes mellitus (DM). Time to discharge was modeled using sex stratified multivariate survival analysis.

Results: The analysis included 657,417 individuals with a total of 1.2-million-person years of observation. An elevated risk of discharge was observed in association with each of the five chronic conditions studied. The increase in adjusted risk of discharge was highest among soldiers with AS (male HR = 2.5, 95% CI 2.1, 3.0; female HR = 2.1, 95% CI 1.4, 3.2) and with DM (male HR = 2.4, 95% CI 2.2, 2.7; female HR = 2.2, 95% CI 1.8, 2.5), followed by those with RA (male HR = 1.8, 95% CI 1.5, 2.2; female HR = 1.8, 95% CI 1.4, 2.4).

Conclusions: Military discharges are consequential for the service and the servicemember. The doubling in risk of discharge for those with AS or RA was comparable to that for personnel with diabetes mellitus. Conditions that affect the spine and peripheral joints may often be incompatible with military readiness. Nevertheless, a substantial fraction of servicemembers with these diagnoses continued in service.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- Before this work, very little has been known about the military trajectories of those developing chronic musculoskeletal and skin conditions.
- Utilizing the total active-duty US Army population from 2014-17, we found a doubling of the adjusted hazard of leaving military service following a diagnosis of ankylosing spondylitis and rheumatoid arthritis.
- Conditions impacting the spine and peripheral joints may present challenges but do not appear invariably incompatible with continued military service.
- Our results cannot necessarily be generalized to other US military branches or to servicemembers of other nations.

INTRODUCTION

Chronic musculoskeletal and skin conditions may pose important challenges for military personnel. In many cases, affected individuals could be unable to carry out their military duties and would thus be given a medical discharge. Given the operational and economic costs of such discharges, as well as the human impact on the soldier from the onset of a chronic disease, it is critical to better understand typical career trajectories in the military following onset of these diseases.[1]

Although military clinicians are provided substantial guidance with respect to both diagnosing and managing musculoskeletal and skin disorders,[2] we were unable to identify prior research specifically addressing the risk of military service terminations associated with diagnoses of these diseases. Insufficient evidence could potentially lead to either hastening service discharges for those still ably serving under effective management or delayed actions that could permit disease progression associated with a subsequent service discharge.[2] Thus, determining the risk of military discharge, if any, associated with such conditions is important for the military mission as well as for clinicians and patients alike.

In this study, our objective was to characterize the associations between a selection of commonly encountered chronic musculoskeletal and skin conditions including ankylosing spondylitis (AS), rheumatoid arthritis (RA), psoriasis (Ps) and systemic lupus erythematosus (SLE), and discharge from service among active-duty service members when adjusting for a range of demographic, health-related, and military-specific characteristics. For comparison, we also analyzed the risk of discharge following diagnosis with diabetes mellitus, which is among the most prevalent chronic diseases in the military population.

METHODS

Data Sources.

We utilized a longitudinal panel dataset from the Stanford Military Data Repository (SMDR), a de-identified dataset comprising administrative and health-related datasets on the active-duty US Army. The current retrospective cohort analysis is based on person-months of active military service among individuals who served with the US Army between January 2014 and June 2017. Demographic and military service data, including terminations of active-duty service, were obtained from official personnel records provided by the Defense Manpower Data Center (DMDC)[3]. The data sources used to identify individuals with our outcomes of interest were the Military Health System Data Repository or MDR[4] which includes records of out- and inpatient care provided to US service members in military as well as civilian facilities, and the "eProfile" system[4], the official system of record in which soldiers' duty restrictions and the clinical diagnoses warranting them are archived.

To identify incident diagnoses of AS, RA, Ps, SLE or DM (either type 1 or 2), we first used the clinical data from the MDR. For encounters occurring between January 2014 and October 2015, conditions were identified using International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) data. ICD-10 codes were used for encounters occurring between November 2015 and June 2017. For each condition, the ICD-9-CM and ICD-10 diagnosis codes were, respectively: AS, 720.0 and M45.x; RA, 714.x and M05.x, M06.x; Ps, 696.x and L40.x; SLE, 710.0 and M32.1x, M32.9x; and DM, 250.x and E.08.x – E.11.x, E13.x.

The second source for identifying incident cases was "eProfile" due to the potential for some cases to solely be diagnosed in eProfile as a summative finding after deferred assignments of definitive diagnoses. Such trajectories could be seen, for example, if diagnoses were uncertain

and were confirmed only by specialists late in the care process after initial primary care evaluation, at which time appropriate duty restrictions might be better understood. A free-text search algorithm was used to filter clinician entries of the selected medical conditions; the accuracy of captured diagnoses was then confirmed with a visual review.

Procedure

Subjects who began their military service during the observed time period were examined for incident diagnoses beginning at the outset of their service. Military enlistment policies require initial screening examinations. Any of the five conditions considered in this study (AS, RA, Ps, SLE, and DM) normally disqualify an individual from induction into service (AR 40-501) [5]. All new soldiers in the dataset were therefore presumed to be free of known diagnoses of these conditions when they entered service.

The remaining individuals entered service at a wide variety of times prior to January 2014 and could therefore have been diagnosed with one or more of these conditions before our study period. Thus, for those soldiers enlisting prior to January 2014, we applied a "wash-out" or "run-in" period in which at least 12 initial months of observation were required. This wash-out period was used to rule out follow-up care for previously diagnosed conditions in their health records and duty restrictions. The one-year duration of the period was chosen because each member is required to undergo an annual Periodic Health Assessment, a health screening[6] in which major medical problems are typically identified. Observation for incident conditions thus began in January 2015 among those entering service prior to January 2014.

Dependent variable

The primary outcome variable was a discharge from service for any reason. The discharge information was identified from the DMDC personnel records.

Independent variables

We included a wide range of independent variables to minimize possible confounding of the associations between the selected disorders and service discharges. Independent variables whose values varied with time were continuously updated in each subject's longitudinal data. The covariates included sex, age, race, marital status, statement of tobacco use at a prior health encounter, active-duty service time and military pay grade, which captures soldiers' socioeconomic status[7].

We categorized the two quantitative variables. We divided individuals in approximate quartiles on the basis of age. For active-duty service time, we categorized in such a way as to capture typical career eras for soldiers. Specifically, we employed a category for <4 years to capture those in their first term of service and a 4–10-year category for people who may be in the decision window before choosing whether to remain in service until retirement. We then divided the remaining subjects into two subgroups: those with >10-16 and >16 years.

In addition, we created a dichotomous variable to capture whether each member held a combat-focused occupation versus a job description functioning in a support role. We also included an additional categorical variable to account for the type of military unit in which the subject served to adjust for any related systematic difference in exposures. The categories were: combat deployable units; those involved in training and administrative functions; special operations forces; medical units; and all other or unknown unit types.

Patient and public involvement

Study participants were not involved in the design, recruitment, or conduct of the study, as this was a retrospective analysis of passively collected data on military service members. All service members will be able to view the study results upon publication of the paper.

Statistical analysis

To provide a descriptive overview of the study population, we examined subjects at the last-available, person-specific monthly observation and stratified on the presence or absence of service discharge. We tested for differences in categorical variable distributions using chi square tests and applied two-sided t-tests for continuous variables.

To estimate adjusted associations between the selected conditions and service discharge, we computed multivariable survival models. The models used the Weibull distribution to estimate adjusted hazard ratios for service discharge. Because of possible differences between males and females in the rates of the conditions being studied and in rates of separation of the Army, the unadjusted and adjusted analyses were sex stratified.

All analyses were conducted using Stata statistical software version 14.2 (StataCorp, College Station, Texas). We considered p-values ≤ 0.05 to be statistically significant.

RESULTS

The analysis included 657,417 eligible subjects who were observed for a total of 1.2 million person-years of time at risk for the regression models. On average, each subject was observed for 1.8 years (median: 2.4; standard deviation [SD]: 0.9). We found that small percentages of subjects with each of the selected medical conditions were additionally detected

when using the eProfile data in addition to MDR information. The relevant findings were as follows for each of the conditions, with the format representing the total number of affected subjects, the number of additional cases solely identified in eProfile and, in parentheses, the percentage of total cases detected solely in eProfile: for AS, 322, 15 (4.7%); for RA, 734, 7 (1.0%); for DM, 2541, 44 (1.7%); for Ps, 2658, 17 (0.6%); and for SLE, 236, 8 (3.4%).

Table 1 presents the unadjusted results for demographic and health behavior variables while Table 2 presents the unadjusted results for military characteristics. Tobacco users were significantly more likely to be discharged than non-users in both sexes (Table 1).

Table 1. Demographic and health behavior characteristics of the U.S. Army study population, 2014-7 (N = 657,417) as of the last person-specific observation. Values represent numbers (percentages).

Factor	Males; n = 560,243 (85.2)		Females; n = 97,174 (14.8)	
	No discharge 386,436 (69.0)	Discharged 173,807 (31.0)	No discharge 66,833 (68.8)	Discharged 30,341 (31.2)
Age, years	$P < 0.001^A$		$P < 0.001^A$	
≤ 22	98,351 (69.1)	43,912 (30.9)	17,941 (64.8)	9754 (35.2)
23 to 27	102,712 (66.1)	52,620 (33.9)	18,487 (68.3)	8591 (31.7)
28 to 35	101,863 (72.0)	39,570 (28.0)	17,733 (72.8)	6621 (27.2)
≥ 36	83,510 (68.9)	37,705 (31.1)	12,672 (70.2)	5375 (29.8)
Race	$P < 0.001^A$		$P < 0.001^A$	

White	269,731 (68.2)	126,022 (31.8)	32,726 (66.8)	16,256 (33.2)
Black	75,041 (69.5)	32,972 (30.5)	24,364 (69.1)	10,899 (30.9)
Asian or Pacific Islander	22,021 (75.0)	7322 (25.0)	5112 (76.0)	1612 (24.0)
Native American or Alaska Native	2711 (66.2)	1381 (33.8)	616 (62.9)	364 (37.1)
Multiracial, other or unspecified	16,932 (73.5)	6110 (26.5)	4015 (76.8)	1210 (23.2)
Marital status	$P < 0.001$[A]		$P = 0.001$[A]	
Married	222,598 (70.3)	94,033 (29.7)	32,376 (69.3)	14,350 (30.7)
Never married	148,065 (67.6)	70,942 (32.4)	26,584 (68.5)	12,243 (31.5)
Formerly married	15,773 (64.1)	8832 (35.9)	7873 (67.8)	3748 (32.2)
Tobacco use	$P < 0.001$[A]		$P < 0.001$[A]	
No	229,160 (71.3)	92,056 (28.7)	52,010 (69.8)	22,503 (30.2)
Yes	157,276 (65.8)	81,751 (34.2)	14,823 (65.4)	7838 (34.6)

Note:

A. Results of chi square tests.

In terms of military characteristics (Table 2), males in combat-focused professions were at the highest unadjusted probability of discharge (33.5% of these men; $P < 0.001$) whereas no association was observed between occupation and discharge among females. Crude associations between military unit type and discharge also varied by sex. Males in medical units had the

highest proportion of those discharged (34.6%); among females, those in training and administrative units were most likely to be discharged (40.6%).

Table 2. Military characteristics of the U.S. Army study population, 2014-7 (N = 657,417) as of the last person-specific observation. Values represent numbers (percentages).

Factor	Males; n = 560,243 (85.2)		Females; n = 97,174 (14.8)	
	No discharge 386,436 (69.0)	Discharged 173,807 (31.0)	No discharge 66,833 (68.8)	Discharged 30,341 (31.2)
Military pay grade	$P < 0.001^A$		$P = 0.001^A$	
≤ E-4	170,482 (62.9)	100,574 (37.1)	30,841 (61.5)	19,310 (38.5)
E-5 & E-6	101,670 (72.5)	38,602 (27.5)	15,433 (74.8)	5200 (25.2)
E-7 to E-9	41,859 (74.1)	14,635 (25.9)	5464 (75.2)	1801 (24.8)
W-1 to O-3	48,957 (78.6)	13,346 (21.4)	10,544 (79.1)	2793 (20.9)
≥ O-4	23,468 (77.9)	6650 (22.1)	4551 (78.6)	1237 (21.4)
Active service time	$P < 0.001^A$		$P < 0.001^A$	
< 4 years	168,536 (68.8)	76,450 (31.2)	32,520 (67.7)	15,502 (32.3)
> 4 to 10 years	102,350 (66.4)	51,694 (33.6)	17,546 (66.6)	8780 (33.4)
> 10 to 16 years	59,802 (77.2)	17,675 (22.8)	9063 (78.6)	2466 (21.4)
> 16 years	55,748 (66.6)	27,988 (33.4)	7704 (68.2)	3593 (31.8)
Combat-focused	$P < 0.001^A$		$P = 0.255^A$	

No	245,696 (70.5)	102,832 (29.5)	63,017 (68.7)	28,704 (31.3)
Yes	140,740 (66.5)	70,975 (33.5)	3726 (69.5)	1637 (30.5)
Military unit type	$P < 0.001$[A]		$P < 0.001$[A]	
Combat-deployable	182,518 (66.0)	94,133 (34.0)	28,819 (68.4)	13,291 (31.6)
Training/administration	68,369 (67.5)	32,949 (32.5)	11,832 (59.4)	8097 (40.6)
Special operations	28,852 (82.2)	6249 (17.8)	1567 (83.2)	317 (16.8)
Medical	15,894 (65.4)	8402 (34.6)	8794 (70.6)	3654 (29.4)
Other/uncertain	90,803 (73.9)	32,074 (26.1)	15,821 (76.0)	4982 (24.0)

Note:

A. Results of chi square tests.

Table 3 presents the unadjusted distributions of study subpopulations organized in terms of their diagnoses. Overall, 31.0% of males and 31.2% of females without the conditions of interest were discharged during the follow-up time. A significantly higher proportion of those with a diagnosis of AS, RA and DM were discharged. Discharges were most common among AS patients with 44.7% of males and 43.1% of females discharged. Among the RA patients, 37.9% of the males and 37.8% of the females were discharged. Among those with DM, 44.5% of the males and 38.9% of the females were discharged. No significant difference in the unadjusted probability of discharge was observed in association with either Ps or SLE. Men and women with psoriasis experienced the lowest discharge rates among subjects with the selected conditions, respectively involving 30.2% and 31.7% of subjects with those diagnostic histories.

Table 3. Disease percentages in the U.S. Army study population, 2014-7 (N = 657,417), stratified by sex and military discharge status, as of the last person-specific observation. Values represent numbers (percentages) and p-values are derived from of chi square tests comparing factor distributions.

Factor	Males; n = 560,243 (85.2)		Females; n = 97,174 (14.8)	
	No discharge 386,436 (69.0)	Discharged 173,807 (31.0)	No discharge 66,833 (68.8)	Discharged 30,341 (31.2)
Ankylosing spondylitis				
Yes	146 (55.3)	118 (44.7)	33 (56.9)	25 (43.1)
No	386,290 (69.0)	173,689 (31.0)	66,800 (68.8)	30,316 (31.2)
	$P < 0.001$		$P = 0.051$	
Rheumatoid arthritis				
Yes	303 (62.1)	185 (37.9)	153 (62.2)	93 (37.8)
No	386,133 (69.0)	173,622 (31.0)	66,680 (68.8)	30,248 (31.2)
	$P = 0.001$		$P = 0.026$	
Psoriasis				
Yes	1534 (69.8)	664 (30.2)	314 (68.3)	146 (31.7)
No	384,902 (69.0)	173,143 (31.0)	66,519 (68.8)	30,195 (31.2)
	$P = 0.408$		$P = 0.811$	

Systemic lupus erythematosus				
Yes	59 (62.8)	35 (37.2)	95 (66.9)	47 (33.1)
No	386,377 (69.0)	173,772 (31.0)	66,738 (68.8)	30,294 (31.2)
	$P = 0.193$		$P = 0.629$	
Diabetes mellitus				
Yes	1175 (55.5)	942 (44.5)	259 (61.1)	165 (38.9)
No	385,261 (69.0)	172,865 (31.0)	66,574 (68.8)	30,176 (31.2)
	$P < 0.001$		$P = 0.001$	

The results of the adjusted models are shown in Table 4. An elevated risk of discharge was observed in association with each of the five chronic conditions studied, relative to soldiers without these conditions during the same time period. The increase in adjusted risk of discharge was highest among soldiers with AS (male HR = 2.5, 95% CI 2.1, 3.0; female HR = 2.1, 95% CI 1.4, 3.2) and with DM (male HR = 2.4, 95% CI 2.2, 2.7; female HR = 2.2, 95% CI 1.8, 2.5), followed by those with RA (male HR = 1.8, 95% CI 1.5, 2.2; female HR = 1.8, 95% CI 1.4, 2.4). For those with Ps, the adjusted hazard of discharge was 40% higher (male HR = 1.4, 95% CI: 1.3, 1.5; female HR = 1.4, 95% CI: 1.2, 1.7). For those with SLE, the adjusted hazard of discharge was 70% higher among males (HR = 1.7, 95% CI: 1.2, 2.3) and 50% higher among females (HR = 1.5, 95% CI: 1.0, 2.1).

Considering the other predictors, the probability of discharge increased significantly with both age and service time (Table 4). Compared to those in the Asian/Pacific Islander category, individuals in each of the "other" race categories were significantly more likely to be discharged.

Relative to those in special operations, hazard of discharge was significantly higher in each of the other types of military units. Finally, those in a combat-focused occupation were slightly but significantly more likely to be discharged than those occupying administrative or support roles.

Table 4. Adjusted hazard ratios (aHR) with 95% confidence intervals (CI) from sex-stratified multivariable Weibull regression models for military service discharge (N = 657,417). Models adjusted for all listed variables.

Factor	Males; n = 560,243		Females; n = 97,174	
	aHR[1]	95% CI	aHR[1]	95% CI
Had ankylosing spondylitis	2.5***	2.1 – 3.0	2.1***	1.4 – 3.2
Had rheumatoid arthritis	1.8***	1.5 – 2.2	1.8***	1.4 – 2.4
Had psoriasis	1.4***	1.3 – 1.5	1.4***	1.2 – 1.7
Had systemic lupus erythematosus	1.7**	1.2 – 2.3	1.5*	1.0 – 2.1
Had diabetes mellitus	2.4***	2.2 – 2.7	2.2***	1.8 – 2.5
Age, years (referent: ≤ 22)				
23 to 27	1.3**	1.1 – 1.5	0.9	0.8 – 1.1
28 to 35	1.4***	1.2 – 1.6	1.0	0.8 – 1.2
≥ 36	1.7***	1.5 – 2.0	1.2	1.0 – 1.4
Race (referent: Asian or Pacific Islander)				
White	1.3***	1.3 – 1.4	1.5***	1.4 – 1.6
Black	1.2***	1.2 – 1.2	1.2***	1.1 – 1.3

Native American or Alaskan	1.3***	1.2 – 1.5	1.5***	1.3 – 1.7
Multiracial, other or unspecified	1.2***	1.1 – 1.2	1.1*	1.0 – 1.2
Marital status (referent: married)				
Never married	1.2***	1.2 – 1.2	0.9*	0.8 – 1.0
Formerly married	1.3***	1.2 – 1.3	1.1***	1.0 – 1.1
Military pay grade (referent: ≥ O-4)				
≤ E-4	6.6***	5.7 – 7.6	5.4***	4.7 – 6.1
E-5 & E-6	2.0***	1.8 – 2.2	1.8***	1.5 – 2.0
E-7 to E-9	1.2**	1.1 – 1.3	1.1	0.9 – 1.2
W-1 to O-3	1.6***	1.4 – 1.7	1.4***	1.3 – 1.6
Active military service time, years (referent: < 4)				
> 4 to 10	2.1***	1.9 – 2.2	2.1***	1.9 – 2.2
> 10 to 16	1.9***	1.8 – 2.1	1.7***	1.5 – 2.0
> 16	3.8***	3.4 – 4.2	3.5***	3.0 – 3.9
Held a combat-focused occupation	1.2***	1.1 – 1.4	1.2*	1.0 – 1.4
Military unit type (referent: special operations)				
Combat-deployable	1.9***	1.8 – 2.0	1.7***	1.4 – 2.0
Training/administration	2.2***	1.8 – 2.8	2.8***	1.9 – 4.0
Medical	2.3***	1.9 – 2.7	1.7***	1.4 – 2.1

Other/uncertain	1.4***	1.2 – 1.7	1.2	1.0 – 1.6
Self-reported tobacco use	1.4***	1.3 – 1.5	1.3***	1.2 – 1.3

1. Statistical significance: ***P<0.001; **P<0.01; *P<0.05.

DISCUSSION

In this large study of the total US Army population between 2014 and 2017, we found that those service members with ankylosing spondylitis and rheumatoid arthritis were approximately twice as likely to be discharged in comparison to peers without these diagnoses. The increase in risk of military discharge was very similar to those soldiers with the comparison condition of diabetes mellitus. Significant elevations in the risk of military discharge were observed in association with each of the conditions studied, ranging from 40% increases for soldiers with psoriasis or systemic lupus erythematosus to 150% increases among males or females with ankylosing spondylitis. It is clear that diagnoses of these conditions are strongly associated with a decreased likelihood of remaining on active-duty military service.

The differences in effect sizes for the selected conditions may be related to occupational limitations, the current state of treatment options, and the possibility that military readiness activities might make the condition worse. For example, given the importance of spine health to military service, AS may be the most limiting, regardless of treatment.[8] It could also be more concerning with respect to the impact of military exposures on disease progression or to the risk of trauma causing spinal fracture. Multiple studies have shown that spinal fractures occur in AS patients at a higher frequency in all ages and disease durations; although most are low impact, many are localized to the cervical spine which in turn could cause serious injury to the spinal cord and result in death[9-15]. Such risks may be elevated in the military, given the physical

conditioning and duties required; service members and clinicians may thus act more conservatively when the diagnosis of AS is made.

Similarly, it would be expected that the diagnosis of RA would represent a challenge to military readiness in both male and female soldiers. Rheumatoid arthritis affects the hands, knees, and feet in such a manner that produces pain, stiffness, and diminished mobility with profound effects, in the untreated patient, on locomotion and fine manipulation[16].

We observed a slightly smaller increase in risk of discharge associated with a diagnosis of SLE, which may reflect the heterogeneity of the condition. Patients with SLE may not have visible signs of the disease; at the same time soldiers with SLE may experience minimal effects of the disease on the musculoskeletal system, which may often be easily managed with anti-inflammatory agents. Alternatively, error with regard to the SLE diagnoses may account for the lower rates of service discharge in this group relative to AS or DM. Anti-nuclear antibodies are necessary for the diagnosis of SLE, but it has been shown that the rate of ANA positivity in the general population is increasing in recent years even in the absence of SLE.[17] It is possible that the comparatively lower rate of discharge of subjects with SLE in this study could reflect misclassification of these subjects with a positive ANA as having a bona-fide diagnosis of SLE as opposed to a false positive test in the subject's health record.

We also observed, comparatively, a relatively minimal impact of psoriasis on military discharge rates. In the most recent report of the NHANES population-based survey of psoriasis prevalence in adults in the United States, psoriasis was quite common (3%) and prevalence has remained largely unchanged over the last two decades[18]. However, the majority of patients with a diagnosis of psoriasis had very few symptoms or findings at the time of the survey suggesting that psoriasis was mild in most cases. If the same pattern were to hold for the Army population,

this could explain the relatively minimal increase in discharge likelihood in association with a psoriasis diagnosis. Interestingly, while we observed no significant difference in the percentages of soldiers discharged with either SLE or psoriasis in the univariate analyses, our adjusted analyses showed significant increases, although reasonably modest, in association with each of these conditions. This indicates confounding by one or more of the covariates we included in our adjusted regression model.

We utilized another chronic disease, diabetes mellitus, as a comparison condition for our study of musculoskeletal and skin conditions. Interestingly, though not a condition that typically impacts the musculoskeletal system, we observed very comparable increases in discharge rates in association with diabetes mellitus compared to ankylosing spondylitis. It is possible that the complexities of disease management of this condition pose challenges in the military operational context.

Our results must be interpreted in light of several limitations. First, the analysis was limited to the Army. It is possible, but not certain, that our results would generalize to the other military branches given commonalities across branches with regard to career-associated physical demands. Further research is needed to clarify the treatment and disease progression trajectories for the selected conditions, many of whom (including RA and AS) can be managed early and aggressively with modern drugs producing an almost disease-free condition with full activity capabilities.

A second limitation is that the analyses depended on administrative data taken from Army records systems rather than, for example, being done with a chart review. For this reason, the diagnoses were not validated, and we had limited visibility on treatments. Our limited access

to clinical findings is an unavoidable constraint. Third, we do not have access to the codes associated with military separation; some discharges may be due to non-medical causes.

In conclusion, our study found elevated risks of discharge from the U.S. Army in association with selected musculoskeletal and skin conditions, several of which have an auto-immune etiology. Such discharges may well reflect basic incompatibilities of some features of these conditions with military readiness in the Army. It should be noted, however, that although discharge rates were elevated following diagnoses, discharge was by no means universal, with a large fraction of individuals remaining in service following diagnosis for the period of our study. Symptoms for each of the conditions manifest on a spectrum of severity, and it is encouraging that many soldiers were able to remain in service despite diagnoses of these chronic medical conditions.

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DATA AVAILABILITY STATEMENT

The data used in this study were provided via agreements with the Defense Health Agency and with the US Army Office of the Surgeon General. These agreements preclude us from making the data available.

CONTRIBUTORSHIP STATEMENT

DAN, RMK, MHW, and LMK all contributed to study design, interpretation of the analyses, and to the drafting of the manuscript. DAN and LMK were responsible for procuring and organizing the data. DAN was responsible for running the analyses.

CONFLICT OF INTEREST

The authors have no financial interests or relationships to disclose.

ETHICS APPROVAL

The study was approved by the institutional review board at Stanford University (Protocol 31161) and also underwent secondary review by the human research protections office of the Defense Health Agency.

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STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract: See methods section of abstract, p. 2, line 30.
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found: See methods and results section of abstract, p. 2, lines 29-40.
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported: See Introduction, p. 4, lines 62-75.
Objectives	3	State specific objectives, including any prespecified hypotheses: See Introduction, p. 4, lines 76-82.
Methods		
Study design	4	Present key elements of study design early in the paper: See Methods, p. 5, lines 86-96.
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection: See Methods, p. 5, lines 86-96.
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up: See Methods, p. 6, lines 113-127.
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed: Not applicable (N/A).
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable: See Methods pp. 5-6, lines 97-110 for the exposures of interest; Methods pp. 6-7, lines 129-131 for the Dependent variable; and Methods p. 7, lines 133-151, for the Independent variables.
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group: See Methods: p. 5, lines 90-110; p. 6, lines 130-131; and p. 7, lines 134-151.
Bias	9	Describe any efforts to address potential sources of bias: See Methods, p. 6, lines 119-127.
Study size	10	Explain how the study size was arrived at: See Methods, p. 6, lines 113-127.
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why: See Methods, p. 7, lines 140-145.
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding: See Methods, p. 8, lines 159-172.
		(*b*) Describe any methods used to examine subgroups and interactions: See Methods p. 8, lines 163-167.
		(*c*) Explain how missing data were addressed: Not applicable to our study.
		(*d*) If applicable, explain how loss to follow-up was addressed: Not applicable to our study.
		(*e*) Describe any sensitivity analyses: Not applicable to our study.
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed: See Results, p. 9, lines 172-173.
		(b) Give reasons for non-participation at each stage: Not applicable to our study.

		(c) Consider use of a flow diagram: Not applicable to our study.
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders: See Table 1, pp. 9-10, lines 185-189 and Table 2, pp. 11-12, lines 198-201.
		(b) Indicate number of participants with missing data for each variable of interest: Not applicable to our study.
		(c) Summarise follow-up time (eg, average and total amount): See Results, p. 8, lines 173-174.
Outcome data	15*	Report numbers of outcome events or summary measures over time: See Table 1, pp. 9-10, lines 185-189.
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included: See Table 3, pp. 13-14, lines 214-219 and Table 4, pp. 15-17, lines 237-240.
		(*b*) Report category boundaries when continuous variables were categorized: See Table 1, p. 9 (age variable); Table 2, p. 11 (active service time variable); Table 4, pp. 15-16 (age and active service time variables).
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period: Not applicable to our study.
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses: Not applicable to our study.
Discussion		
Key results	18	Summarise key results with reference to study objectives: See first paragraph of the Discussion section, p. 17, lines 243-251.
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias: See Discussion section, p. 18, lines 271-277 and pp. 19-20, lines 296-307.
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence: See Discussion section, p. 20, lines 308-316.
Generalisability	21	Discuss the generalisability (external validity) of the study results: See seventh paragraph of the Discussion section, p. 19, lines 297-299.
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based: See the Funding section, p. 20, lines 326-328.

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

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Service Discharges Among US Army Personnel with Selected Musculoskeletal and Skin Conditions: A Retrospective Cohort Study

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Service Discharges Among US Army Personnel with Selected Musculoskeletal and Skin Conditions: A Retrospective Cohort Study

D. Alan Nelson, PhD;[1] Robert M. Kaplan, PhD;[2] Michael H. Weisman, MD;[3] Lianne M. Kurina, PhD[1]

Affiliations

1. Department of Medicine, Division of Primary Care and Population Health, Stanford University School of Medicine, Stanford CA, USA

2. Clinical Excellence Research Center, Stanford University School of Medicine, Stanford CA, USA

3. Department of Medicine, Division of Rheumatology, Stanford University School of Medicine, Department of Medicine, Division of Rheumatology

Corresponding author: Lianne Kurina, 450 Jane Stanford Way, Building 20, Stanford University, Stanford CA 94305-2160; lkurina@stanford.edu

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ABSTRACT

Objectives: To determine the probability of discharge from military service among soldiers following an incident diagnosis of ankylosing spondylitis (AS), rheumatoid arthritis (RA), psoriasis (Ps) or systemic lupus erythematous (SLE).

Methods: All soldiers on active duty in the U.S. Army between January 2014 and June 2017 were included in a retrospective cohort analysis. Termination from service was ascertained using personnel records. Diagnostic codes were used to identify incident cases of the four musculoskeletal and skin diseases and, for comparison, diabetes mellitus (DM). Time to discharge was modeled using sex stratified multivariate survival analysis.

Results: The analysis included 657,417 individuals with a total of 1.2-million-person years of observation. An elevated risk of discharge was observed in association with each of the five chronic conditions studied. The increase in adjusted risk of discharge was highest among soldiers with AS (male HR = 2.5, 95% CI 2.1, 3.0; female HR = 2.1, 95% CI 1.4, 3.2) and with DM (male HR = 2.4, 95% CI 2.2, 2.7; female HR = 2.2, 95% CI 1.8, 2.5), followed by those with RA (male HR = 1.8, 95% CI 1.5, 2.2; female HR = 1.8, 95% CI 1.4, 2.4).

Conclusions: Military discharges are consequential for the service and the servicemember. The doubling in risk of discharge for those with AS or RA was comparable to that for personnel with diabetes mellitus. Conditions that affect the spine and peripheral joints may often be incompatible with military readiness. Nevertheless, a substantial fraction of servicemembers with these diagnoses continued in service.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- Before this work, very little has been known about the military trajectories of those developing chronic musculoskeletal and skin conditions.
- Utilizing the total active-duty US Army population from 2014-17, we found a doubling of the adjusted hazard of leaving military service following a diagnosis of ankylosing spondylitis and rheumatoid arthritis.
- Conditions impacting the spine and peripheral joints may present challenges but do not appear invariably incompatible with continued military service.
- Our results cannot necessarily be generalized to other US military branches or to servicemembers of other nations.

INTRODUCTION

Chronic musculoskeletal and skin conditions may pose important challenges for military personnel. In many cases, affected individuals could be unable to carry out their military duties and would thus be given a medical discharge. Given the operational and economic costs of such discharges, as well as the human impact on the soldier from the onset of a chronic disease, it is critical to better understand typical career trajectories in the military following onset of these diseases.[1]

Although military clinicians are provided substantial guidance with respect to both diagnosing and managing musculoskeletal and skin disorders,[2] we were unable to identify prior research specifically addressing the risk of military service terminations associated with diagnoses of these diseases. Insufficient evidence could potentially lead to either hastening service discharges for those still ably serving under effective management or delayed actions that could permit disease progression associated with a subsequent service discharge.[2] Thus, determining the risk of military discharge, if any, associated with such conditions is important for the military mission as well as for clinicians and patients alike.

In this study, our objective was to characterize the associations between a selection of commonly encountered chronic musculoskeletal and skin conditions including ankylosing spondylitis (AS), rheumatoid arthritis (RA), psoriasis (Ps) and systemic lupus erythematosus (SLE), and discharge from service among active-duty service members when adjusting for a range of demographic, health-related, and military-specific characteristics. For comparison, we also analyzed the risk of discharge following diagnosis with diabetes mellitus, which is among the most prevalent chronic diseases in the military population.

METHODS

Data Sources.

We utilized a longitudinal panel dataset from the Stanford Military Data Repository (SMDR), a de-identified dataset comprising administrative and health-related datasets on the active-duty US Army. The current retrospective cohort analysis is based on person-months of active military service among individuals who served with the US Army between January 2014 and June 2017. Demographic and military service data, including terminations of active-duty service, were obtained from official personnel records provided by the Defense Manpower Data Center (DMDC)[3]. The data sources used to identify individuals with our outcomes of interest were the Military Health System Data Repository or MDR[4] which includes records of out- and inpatient care provided to US service members in military as well as civilian facilities, and the "eProfile" system[4], the official system of record in which soldiers' duty restrictions and the clinical diagnoses warranting them are archived.

To identify incident diagnoses of AS, RA, Ps, SLE or DM (either type 1 or 2), we first used the clinical data from the MDR. For encounters occurring between January 2014 and October 2015, conditions were identified using International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) data. ICD-10 codes were used for encounters occurring between November 2015 and June 2017. For each condition, the ICD-9-CM and ICD-10 diagnosis codes were, respectively: AS, 720.0 and M45.x; RA, 714.x and M05.x, M06.x; Ps, 696.x and L40.x; SLE, 710.0 and M32.1x, M32.9x; and DM, 250.x and E.08.x – E.11.x, E13.x.

The second source for identifying incident cases was "eProfile" due to the potential for some cases to solely be diagnosed in eProfile as a summative finding after deferred assignments of definitive diagnoses. Such trajectories could be seen, for example, if diagnoses were uncertain

and were confirmed only by specialists late in the care process after initial primary care evaluation, at which time appropriate duty restrictions might be better understood. A free-text search algorithm was used to filter clinician entries of the selected medical conditions; the accuracy of captured diagnoses was then confirmed with a visual review.

Procedure

Subjects who began their military service during the observed time period were examined for incident diagnoses beginning at the outset of their service. Military enlistment policies require initial screening examinations. Any of the five conditions considered in this study (AS, RA, Ps, SLE, and DM) normally disqualify an individual from induction into service (AR 40-501) [5]. All new soldiers in the dataset were therefore presumed to be free of known diagnoses of these conditions when they entered service.

The remaining individuals entered service at a wide variety of times prior to January 2014 and could therefore have been diagnosed with one or more of these conditions before our study period. Thus, for those soldiers enlisting prior to January 2014, we applied a "wash-out" or "run-in" period in which at least 12 initial months of observation were required. This wash-out period was used to rule out follow-up care for previously diagnosed conditions in their health records and duty restrictions. The one-year duration of the period was chosen because each member is required to undergo an annual Periodic Health Assessment, a health screening[6] in which major medical problems are typically identified. Observation for incident conditions thus began in January 2015 among those entering service prior to January 2014.

Dependent variable

The primary outcome variable was a discharge from service for any reason. The discharge information was identified from the DMDC personnel records.

Independent variables

We included a wide range of independent variables to minimize possible confounding of the associations between the selected disorders and service discharges. Independent variables whose values varied with time were continuously updated in each subject's longitudinal data. The covariates included sex, age, race, marital status, statement of tobacco use at a prior health encounter, active-duty service time and military pay grade, which captures soldiers' socioeconomic status[7].

We categorized the two quantitative variables. We divided individuals in approximate quartiles on the basis of age. For active-duty service time, we categorized in such a way as to capture typical career eras for soldiers. Specifically, we employed a category for <4 years to capture those in their first term of service and a 4–10-year category for people who may be in the decision window before choosing whether to remain in service until retirement. We then divided the remaining subjects into two subgroups: those with >10-16 and >16 years.

In addition, we created a dichotomous variable to capture whether each member held a combat-focused occupation versus a job description functioning in a support role. We also included an additional categorical variable to account for the type of military unit in which the subject served to adjust for any related systematic difference in exposures. The categories were: combat deployable units; those involved in training and administrative functions; special operations forces; medical units; and all other or unknown unit types.

Patient and public involvement

Study participants were not involved in the design, recruitment, or conduct of the study, as this was a retrospective analysis of passively collected data on military service members. All service members will be able to view the study results upon publication of the paper.

Statistical analysis

To provide a descriptive overview of the study population, we examined subjects at the last-available, person-specific monthly observation and stratified on the presence or absence of service discharge. We tested for differences in categorical variable distributions using chi square tests and applied two-sided t-tests for continuous variables.

To estimate adjusted associations between the selected conditions and service discharge, we computed multivariable survival models. The models used the Weibull distribution to estimate adjusted hazard ratios for service discharge. Because of possible differences between males and females in the rates of the conditions being studied and in rates of separation of the Army, the unadjusted and adjusted analyses were sex stratified.

All analyses were conducted using Stata statistical software version 14.2 (StataCorp, College Station, Texas). We considered p-values ≤ 0.05 to be statistically significant.

RESULTS

The analysis included 657,417 eligible subjects who were observed for a total of 1.2 million person-years of time at risk for the regression models. On average, each subject was observed for 1.8 years (median: 2.4; standard deviation [SD]: 0.9). We found that small percentages of subjects with each of the selected medical conditions were additionally detected

when using the eProfile data in addition to MDR information. The relevant findings were as follows for each of the conditions, with the format representing the total number of affected subjects, the number of additional cases solely identified in eProfile and, in parentheses, the percentage of total cases detected solely in eProfile: for AS, 322, 15 (4.7%); for RA, 734, 7 (1.0%); for DM, 2541, 44 (1.7%); for Ps, 2658, 17 (0.6%); and for SLE, 236, 8 (3.4%).

Table 1 presents the unadjusted results for demographic and health behavior variables while Table 2 presents the unadjusted results for military characteristics. Tobacco users were significantly more likely to be discharged than non-users in both sexes (Table 1).

Table 1. Demographic and health behavior characteristics of the U.S. Army study population, 2014-7 (N = 657,417) as of the last person-specific observation. Values represent numbers (percentages).

Factor	Males; n = 560,243 (85.2)		Females; n = 97,174 (14.8)	
	No discharge 386,436 (69.0)	Discharged 173,807 (31.0)	No discharge 66,833 (68.8)	Discharged 30,341 (31.2)
Age, years	$P < 0.001^A$		$P < 0.001^A$	
≤ 22	98,351 (69.1)	43,912 (30.9)	17,941 (64.8)	9754 (35.2)
23 to 27	102,712 (66.1)	52,620 (33.9)	18,487 (68.3)	8591 (31.7)
28 to 35	101,863 (72.0)	39,570 (28.0)	17,733 (72.8)	6621 (27.2)
≥ 36	83,510 (68.9)	37,705 (31.1)	12,672 (70.2)	5375 (29.8)
Race	$P < 0.001^A$		$P < 0.001^A$	

White	269,731 (68.2)	126,022 (31.8)	32,726 (66.8)	16,256 (33.2)
Black	75,041 (69.5)	32,972 (30.5)	24,364 (69.1)	10,899 (30.9)
Asian or Pacific Islander	22,021 (75.0)	7322 (25.0)	5112 (76.0)	1612 (24.0)
Native American or Alaska Native	2711 (66.2)	1381 (33.8)	616 (62.9)	364 (37.1)
Multiracial, other or unspecified	16,932 (73.5)	6110 (26.5)	4015 (76.8)	1210 (23.2)
Marital status	$P < 0.001$[A]		$P = 0.001$[A]	
Married	222,598 (70.3)	94,033 (29.7)	32,376 (69.3)	14,350 (30.7)
Never married	148,065 (67.6)	70,942 (32.4)	26,584 (68.5)	12,243 (31.5)
Formerly married	15,773 (64.1)	8832 (35.9)	7873 (67.8)	3748 (32.2)
Tobacco use	$P < 0.001$[A]		$P < 0.001$[A]	
No	229,160 (71.3)	92,056 (28.7)	52,010 (69.8)	22,503 (30.2)
Yes	157,276 (65.8)	81,751 (34.2)	14,823 (65.4)	7838 (34.6)

Note:

A. Results of chi square tests.

In terms of military characteristics (Table 2), males in combat-focused professions were at the highest unadjusted probability of discharge (33.5% of these men; $P < 0.001$) whereas no association was observed between occupation and discharge among females. Crude associations between military unit type and discharge also varied by sex. Males in medical units had the

highest proportion of those discharged (34.6%); among females, those in training and administrative units were most likely to be discharged (40.6%).

Table 2. Military characteristics of the U.S. Army study population, 2014-7 (N = 657,417) as of the last person-specific observation. Values represent numbers (percentages).

Factor	Males; n = 560,243 (85.2)		Females; n = 97,174 (14.8)	
	No discharge 386,436 (69.0)	Discharged 173,807 (31.0)	No discharge 66,833 (68.8)	Discharged 30,341 (31.2)
Military pay grade	$P < 0.001^A$		$P = 0.001^A$	
≤ E-4	170,482 (62.9)	100,574 (37.1)	30,841 (61.5)	19,310 (38.5)
E-5 & E-6	101,670 (72.5)	38,602 (27.5)	15,433 (74.8)	5200 (25.2)
E-7 to E-9	41,859 (74.1)	14,635 (25.9)	5464 (75.2)	1801 (24.8)
W-1 to O-3	48,957 (78.6)	13,346 (21.4)	10,544 (79.1)	2793 (20.9)
≥ O-4	23,468 (77.9)	6650 (22.1)	4551 (78.6)	1237 (21.4)
Active service time	$P < 0.001^A$		$P < 0.001^A$	
< 4 years	168,536 (68.8)	76,450 (31.2)	32,520 (67.7)	15,502 (32.3)
> 4 to 10 years	102,350 (66.4)	51,694 (33.6)	17,546 (66.6)	8780 (33.4)
> 10 to 16 years	59,802 (77.2)	17,675 (22.8)	9063 (78.6)	2466 (21.4)
> 16 years	55,748 (66.6)	27,988 (33.4)	7704 (68.2)	3593 (31.8)
Combat-focused	$P < 0.001^A$		$P = 0.255^A$	

No	245,696 (70.5)	102,832 (29.5)	63,017 (68.7)	28,704 (31.3)
Yes	140,740 (66.5)	70,975 (33.5)	3726 (69.5)	1637 (30.5)
Military unit type	$P < 0.001$[A]		$P < 0.001$[A]	
Combat-deployable	182,518 (66.0)	94,133 (34.0)	28,819 (68.4)	13,291 (31.6)
Training/administration	68,369 (67.5)	32,949 (32.5)	11,832 (59.4)	8097 (40.6)
Special operations	28,852 (82.2)	6249 (17.8)	1567 (83.2)	317 (16.8)
Medical	15,894 (65.4)	8402 (34.6)	8794 (70.6)	3654 (29.4)
Other/uncertain	90,803 (73.9)	32,074 (26.1)	15,821 (76.0)	4982 (24.0)

Note:

A. Results of chi square tests.

Table 3 presents the unadjusted distributions of study subpopulations organized in terms of their diagnoses. Overall, 31.0% of males and 31.2% of females without the conditions of interest were discharged during the follow-up time. A significantly higher proportion of those with a diagnosis of AS, RA and DM were discharged. Discharges were most common among AS patients with 44.7% of males and 43.1% of females discharged. Among the RA patients, 37.9% of the males and 37.8% of the females were discharged. Among those with DM, 44.5% of the males and 38.9% of the females were discharged. No significant difference in the unadjusted probability of discharge was observed in association with either Ps or SLE. Men and women with psoriasis experienced the lowest discharge rates among subjects with the selected conditions, respectively involving 30.2% and 31.7% of subjects with those diagnostic histories.

Table 3. Disease percentages in the U.S. Army study population, 2014-7 (N = 657,417), stratified by sex and military discharge status, as of the last person-specific observation. Values represent numbers (percentages) and p-values are derived from of chi square tests comparing factor distributions.

Factor	Males; n = 560,243 (85.2)		Females; n = 97,174 (14.8)	
	No discharge 386,436 (69.0)	Discharged 173,807 (31.0)	No discharge 66,833 (68.8)	Discharged 30,341 (31.2)
Ankylosing spondylitis				
Yes	146 (55.3)	118 (44.7)	33 (56.9)	25 (43.1)
No	386,290 (69.0)	173,689 (31.0)	66,800 (68.8)	30,316 (31.2)
	$P < 0.001$		$P = 0.051$	
Rheumatoid arthritis				
Yes	303 (62.1)	185 (37.9)	153 (62.2)	93 (37.8)
No	386,133 (69.0)	173,622 (31.0)	66,680 (68.8)	30,248 (31.2)
	$P = 0.001$		$P = 0.026$	
Psoriasis				
Yes	1534 (69.8)	664 (30.2)	314 (68.3)	146 (31.7)
No	384,902 (69.0)	173,143 (31.0)	66,519 (68.8)	30,195 (31.2)
	$P = 0.408$		$P = 0.811$	

Systemic lupus erythematosus				
Yes	59 (62.8)	35 (37.2)	95 (66.9)	47 (33.1)
No	386,377 (69.0)	173,772 (31.0)	66,738 (68.8)	30,294 (31.2)
	$P = 0.193$		$P = 0.629$	
Diabetes mellitus				
Yes	1175 (55.5)	942 (44.5)	259 (61.1)	165 (38.9)
No	385,261 (69.0)	172,865 (31.0)	66,574 (68.8)	30,176 (31.2)
	$P < 0.001$		$P = 0.001$	

The results of the adjusted models are shown in Table 4. An elevated risk of discharge was observed in association with each of the five chronic conditions studied, relative to soldiers without these conditions during the same time period. The increase in adjusted risk of discharge was highest among soldiers with AS (male HR = 2.5, 95% CI 2.1, 3.0; female HR = 2.1, 95% CI 1.4, 3.2) and with DM (male HR = 2.4, 95% CI 2.2, 2.7; female HR = 2.2, 95% CI 1.8, 2.5), followed by those with RA (male HR = 1.8, 95% CI 1.5, 2.2; female HR = 1.8, 95% CI 1.4, 2.4). For those with Ps, the adjusted hazard of discharge was 40% higher (male HR = 1.4, 95% CI: 1.3, 1.5; female HR = 1.4, 95% CI: 1.2, 1.7). For those with SLE, the adjusted hazard of discharge was 70% higher among males (HR = 1.7, 95% CI: 1.2, 2.3) and 50% higher among females (HR = 1.5, 95% CI: 1.0, 2.1).

Considering the other predictors, the probability of discharge increased significantly with both age and service time (Table 4). Compared to those in the Asian/Pacific Islander category, individuals in each of the "other" race categories were significantly more likely to be discharged.

Relative to those in special operations, hazard of discharge was significantly higher in each of the other types of military units. Finally, those in a combat-focused occupation were slightly but significantly more likely to be discharged than those occupying administrative or support roles.

Table 4. Adjusted hazard ratios (aHR) with 95% confidence intervals (CI) from sex-stratified multivariable Weibull regression models for military service discharge (N = 657,417). Models adjusted for all listed variables.

Factor	Males; n = 560,243		Females; n = 97,174	
	aHR[1]	95% CI	aHR[1]	95% CI
Had ankylosing spondylitis	2.5***	2.1 – 3.0	2.1***	1.4 – 3.2
Had rheumatoid arthritis	1.8***	1.5 – 2.2	1.8***	1.4 – 2.4
Had psoriasis	1.4***	1.3 – 1.5	1.4***	1.2 – 1.7
Had systemic lupus erythematosus	1.7**	1.2 – 2.3	1.5*	1.0 – 2.1
Had diabetes mellitus	2.4***	2.2 – 2.7	2.2***	1.8 – 2.5
Age, years (referent: ≤ 22)				
23 to 27	1.3**	1.1 – 1.5	0.9	0.8 – 1.1
28 to 35	1.4***	1.2 – 1.6	1.0	0.8 – 1.2
≥ 36	1.7***	1.5 – 2.0	1.2	1.0 – 1.4
Race (referent: Asian or Pacific Islander)				
White	1.3***	1.3 – 1.4	1.5***	1.4 – 1.6
Black	1.2***	1.2 – 1.2	1.2***	1.1 – 1.3

Native American or Alaskan	1.3***	1.2 – 1.5	1.5***	1.3 – 1.7
Multiracial, other or unspecified	1.2***	1.1 – 1.2	1.1*	1.0 – 1.2
Marital status (referent: married)				
Never married	1.2***	1.2 – 1.2	0.9*	0.8 – 1.0
Formerly married	1.3***	1.2 – 1.3	1.1***	1.0 – 1.1
Military pay grade (referent: ≥ O-4)				
≤ E-4	6.6***	5.7 – 7.6	5.4***	4.7 – 6.1
E-5 & E-6	2.0***	1.8 – 2.2	1.8***	1.5 – 2.0
E-7 to E-9	1.2**	1.1 – 1.3	1.1	0.9 – 1.2
W-1 to O-3	1.6***	1.4 – 1.7	1.4***	1.3 – 1.6
Active military service time, years (referent: < 4)				
> 4 to 10	2.1***	1.9 – 2.2	2.1***	1.9 – 2.2
> 10 to 16	1.9***	1.8 – 2.1	1.7***	1.5 – 2.0
> 16	3.8***	3.4 – 4.2	3.5***	3.0 – 3.9
Held a combat-focused occupation	1.2***	1.1 – 1.4	1.2*	1.0 – 1.4
Military unit type (referent: special operations)				
Combat-deployable	1.9***	1.8 – 2.0	1.7***	1.4 – 2.0
Training/administration	2.2***	1.8 – 2.8	2.8***	1.9 – 4.0
Medical	2.3***	1.9 – 2.7	1.7***	1.4 – 2.1

Other/uncertain	1.4***	1.2 – 1.7	1.2	1.0 – 1.6
Self-reported tobacco use	1.4***	1.3 – 1.5	1.3***	1.2 – 1.3

1. Statistical significance: ***P<0.001; **P<0.01; *P<0.05.

DISCUSSION

In this large study of the total US Army population between 2014 and 2017, we found that those service members with ankylosing spondylitis and rheumatoid arthritis were approximately twice as likely to be discharged in comparison to peers without these diagnoses. The increase in risk of military discharge was very similar to those soldiers with the comparison condition of diabetes mellitus. Significant elevations in the risk of military discharge were observed in association with each of the conditions studied, ranging from 40% increases for soldiers with psoriasis or systemic lupus erythematosus to 150% increases among males or females with ankylosing spondylitis. It is clear that diagnoses of these conditions are strongly associated with a decreased likelihood of remaining on active-duty military service.

The differences in effect sizes for the selected conditions may be related to occupational limitations, the current state of treatment options, and the possibility that military readiness activities might make the condition worse. For example, given the importance of spine health to military service, AS may be the most limiting, regardless of treatment.[8] It could also be more concerning with respect to the impact of military exposures on disease progression or to the risk of trauma causing spinal fracture. Multiple studies have shown that spinal fractures occur in AS patients at a higher frequency in all ages and disease durations; although most are low impact, many are localized to the cervical spine which in turn could cause serious injury to the spinal cord and result in death[9-15]. Such risks may be elevated in the military, given the physical

conditioning and duties required; service members and clinicians may thus act more conservatively when the diagnosis of AS is made.

Similarly, it would be expected that the diagnosis of RA would represent a challenge to military readiness in both male and female soldiers. Rheumatoid arthritis affects the hands, knees, and feet in such a manner that produces pain, stiffness, and diminished mobility with profound effects, in the untreated patient, on locomotion and fine manipulation[16].

We observed a slightly smaller increase in risk of discharge associated with a diagnosis of SLE, which may reflect the heterogeneity of the condition. Patients with SLE may not have visible signs of the disease; at the same time soldiers with SLE may experience minimal effects of the disease on the musculoskeletal system, which may often be easily managed with anti-inflammatory agents. Alternatively, error with regard to the SLE diagnoses may account for the lower rates of service discharge in this group relative to AS or DM. Anti-nuclear antibodies are necessary for the diagnosis of SLE, but it has been shown that the rate of ANA positivity in the general population is increasing in recent years even in the absence of SLE.[17] It is possible that the comparatively lower rate of discharge of subjects with SLE in this study could reflect misclassification of these subjects with a positive ANA as having a bona-fide diagnosis of SLE as opposed to a false positive test in the subject's health record.

We also observed, comparatively, a relatively minimal impact of psoriasis on military discharge rates. In the most recent report of the NHANES population-based survey of psoriasis prevalence in adults in the United States, psoriasis was quite common (3%) and prevalence has remained largely unchanged over the last two decades[18]. However, the majority of patients with a diagnosis of psoriasis had very few symptoms or findings at the time of the survey suggesting that psoriasis was mild in most cases. If the same pattern were to hold for the Army population,

this could explain the relatively minimal increase in discharge likelihood in association with a psoriasis diagnosis. Interestingly, while we observed no significant difference in the percentages of soldiers discharged with either SLE or psoriasis in the univariate analyses, our adjusted analyses showed significant increases, although reasonably modest, in association with each of these conditions. This indicates confounding by one or more of the covariates we included in our adjusted regression model.

We utilized another chronic disease, diabetes mellitus, as a comparison condition for our study of musculoskeletal and skin conditions. Interestingly, though not a condition that typically impacts the musculoskeletal system, we observed very comparable increases in discharge rates in association with diabetes mellitus compared to ankylosing spondylitis. It is possible that the complexities of disease management of this condition pose challenges in the military operational context.

Our results must be interpreted in light of several limitations. First, the analysis was limited to the Army. It is possible, but not certain, that our results would generalize to the other military branches given commonalities across branches with regard to career-associated physical demands. Further research is needed to clarify the treatment and disease progression trajectories for the selected conditions, many of whom (including RA and AS) can be managed early and aggressively with modern drugs producing an almost disease-free condition with full activity capabilities.

A second limitation is that the analyses depended on administrative data taken from Army records systems rather than, for example, being done with a chart review. For this reason, the diagnoses were not validated, and we had limited visibility on treatments. Our limited access

to clinical findings is an unavoidable constraint. Third, we do not have access to the codes associated with military separation; some discharges may be due to non-medical causes.

In conclusion, our study found elevated risks of discharge from the U.S. Army in association with selected musculoskeletal and skin conditions, several of which have an auto-immune etiology. Such discharges may well reflect basic incompatibilities of some features of these conditions with military readiness in the Army. It should be noted, however, that although discharge rates were elevated following diagnoses, discharge was by no means universal, with a large fraction of individuals remaining in service following diagnosis for the period of our study. Symptoms for each of the conditions manifest on a spectrum of severity, and it is encouraging that many soldiers were able to remain in service despite diagnoses of these chronic medical conditions.

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DATA AVAILABILITY STATEMENT

The data used in this study were provided via agreements with the Defense Health Agency and with the US Army Office of the Surgeon General. These agreements preclude us from making the data available.

CONTRIBUTORSHIP STATEMENT

DAN, RMK, MHW, and LMK all contributed to study design, interpretation of the analyses, and to the drafting of the manuscript. DAN and LMK were responsible for procuring and organizing the data. DAN was responsible for running the analyses.

CONFLICT OF INTEREST

The authors have no financial interests or relationships to disclose.

ETHICS APPROVAL

The study was approved by the institutional review board at Stanford University (Protocol 31161) and also underwent secondary review by the human research protections office of the Defense Health Agency.

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STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract: See methods section of abstract, p. 2, line 30.
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found: See methods and results section of abstract, p. 2, lines 29-40.
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported: See Introduction, p. 4, lines 62-75.
Objectives	3	State specific objectives, including any prespecified hypotheses: See Introduction, p. 4, lines 76-82.
Methods		
Study design	4	Present key elements of study design early in the paper: See Methods, p. 5, lines 86-96.
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection: See Methods, p. 5, lines 86-96.
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up: See Methods, p. 6, lines 113-127.
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed: Not applicable (N/A).
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable: See Methods pp. 5-6, lines 97-110 for the exposures of interest; Methods pp. 6-7, lines 129-131 for the Dependent variable; and Methods p. 7, lines 133-151, for the Independent variables.
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group: See Methods: p. 5, lines 90-110; p. 6, lines 130-131; and p. 7, lines 134-151.
Bias	9	Describe any efforts to address potential sources of bias: See Methods, p. 6, lines 119-127.
Study size	10	Explain how the study size was arrived at: See Methods, p. 6, lines 113-127.
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why: See Methods, p. 7, lines 140-145.
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding: See Methods, p. 8, lines 159-172.
		(*b*) Describe any methods used to examine subgroups and interactions: See Methods p. 8, lines 163-167.
		(*c*) Explain how missing data were addressed: Not applicable to our study.
		(*d*) If applicable, explain how loss to follow-up was addressed: Not applicable to our study.
		(*e*) Describe any sensitivity analyses: Not applicable to our study.
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed: See Results, p. 9, lines 172-173.
		(b) Give reasons for non-participation at each stage: Not applicable to our study.

		(c) Consider use of a flow diagram: Not applicable to our study.
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders: See Table 1, pp. 9-10, lines 185-189 and Table 2, pp. 11-12, lines 198-201.
		(b) Indicate number of participants with missing data for each variable of interest: Not applicable to our study.
		(c) Summarise follow-up time (eg, average and total amount): See Results, p. 8, lines 173-174.
Outcome data	15*	Report numbers of outcome events or summary measures over time: See Table 1, pp. 9-10, lines 185-189.
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included: See Table 3, pp. 13-14, lines 214-219 and Table 4, pp. 15-17, lines 237-240.
		(*b*) Report category boundaries when continuous variables were categorized: See Table 1, p. 9 (age variable); Table 2, p. 11 (active service time variable); Table 4, pp. 15-16 (age and active service time variables).
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period: Not applicable to our study.
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses: Not applicable to our study.
Discussion		
Key results	18	Summarise key results with reference to study objectives: See first paragraph of the Discussion section, p. 17, lines 243-251.
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias: See Discussion section, p. 18, lines 271-277 and pp. 19-20, lines 296-307.
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence: See Discussion section, p. 20, lines 308-316.
Generalisability	21	Discuss the generalisability (external validity) of the study results: See seventh paragraph of the Discussion section, p. 19, lines 297-299.
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based: See the Funding section, p. 20, lines 326-328.

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.