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Incidence of Carpal Tunnel Syndrome in the US Military Population

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Abstract Carpal tunnel syndrome (CTS) is a common disease. Its epidemiology has been evaluated previously, mostly in regional populations or in working groups, with an incidence between 1.5 and 3.5 per 1,000 person-years. We studied this diagnosis in the US military population, with the hypothesis that this young population would have a lower incidence of CTS than previously reported in general populations. The Defense Medical Epidemiology Database notes all medical encounters for all US military personnel and maintains the number of all personnel on active duty each year. We queried the database using the International Classification of Diseases, ninth revision, code 354.0 (CTS) and analyzed the personnel presenting for initial visits for the years 1998–2006. Multivariate Poisson analysis was performed, controlling for rank, gender, age, and race. The raw incidence of CTS in the US military was 3.98 per 1,000 person-years, in a population of 12,298,088 person-years. Females had a significantly higher incidence of CTS than males, with an adjusted incidence rate ratio of 3.29. CTS incidence increased by age, with the age group ≥40 years having a significantly higher incidence. Additionally, military rank was found to be an independent risk factor for CTS, with rates higher in senior officer and enlisted groups. This suggests that occupational requirements have an effect on CTS within the military. We showed a comparable incidence of CTS between the US military and general population, with a significantly higher female cohort with a diagnosis of CTS. Increased age and advanced rank were risk factors for CTS.

Keywords Carpal tunnel syndrome · Epidemiology · Military

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Introduction

Compression of the median nerve at the wrist is a common diagnosis, with clinical symptoms of numbness, tingling, and pain in the upper extremity [5]. Women are thought to be affected more frequently than men, and risk factors associated with carpal tunnel syndrome include obesity, vibratory tool use, diabetes, hypothyroidism, and rheumatoid arthritis [16]. Carpal tunnel syndrome is diagnosed by a constellation of symptoms which include nocturnal numbness and pain and daytime paresthesias and weakness. Provocative tests are used, including Phalen's and Durkan's tests (carpal tunnel compression testing). An objective measure of median nerve compression is obtained with electrodiagnostic testing, although nerve conduction studies and electromyography have a false-negative rate reported at 15–25% [8, 19].

The epidemiology of carpal tunnel syndrome has been reported in general populations, mainly in specific regional or national groups or in working populations related to workers' compensation claims. Studies in the Netherlands [4, 6], Italy [10], and in the US [12, 17] have focused on single cities or regions and have noted incidence rates from 1.3 to 3.5 per 1,000 person-years. Other demographic studies have shown a higher incidence of carpal tunnel syndrome in working populations [15], consistent with data showing that repetitive motion of the wrist may be contributory to the symptoms of carpal tunnel syndrome [11]. However, Atroshi et al. [2] recently showed that high keyboard use at work was not associated with a higher incidence of carpal tunnel syndrome.

In this study, we evaluated the incidence of carpal tunnel syndrome by diagnosis code use in a database which encompasses all US military personnel. This population includes all regions of the geographic US as well as service members stationed overseas, providing a large denominator for epidemiologic analysis. Our hypothesis was that this predominantly young and active population would have a lower incidence of carpal tunnel syndrome than has been noted in general population analyses.

Materials and Methods

The Defense Medical Epidemiology Database (DMED) compiles International Classification of Diseases, Ninth Revision, and Clinical Modification (ICD-9-CM) coding information for every patient encounter occurring in a US military treatment facility, in addition to maintaining the total number of US soldiers on active duty each year. This database also contains patient demographic and military-specific data which can be used for epidemiological purposes.

To determine the total number of military personnel with a coded diagnosis of carpal tunnel syndrome, we queried the DMED system by race, gender, military service, rank, and age for the years 1998–2006 using the ICD-9-CM code 354.0. Diagnosis codes are determined by each provider of care; this includes primary care and specialty physicians. The service categories used were Army, Navy, Air Force, and Marines. The rank categories we used were junior enlisted (E1–E4), senior enlisted (E5–E9), junior officer (O1–O3), and senior officer (O4–O9). The age categories used were <20, 20–24, 25–29, 30–34, 35–39, and ≥40 years. Inpatient data were excluded to capture only ambulatory encounters. Events were limited to a "first occurrence" to exclude repeat coding of the same initial diagnostic presentation for all services during the study period. The database was also queried for the total number of service members on active duty during the study time period by race, gender, service, rank, and age. One exposure year was defined as 1 year that the service member was in the Armed Forces.

We used multivariate Poisson regression to estimate the rate of carpal tunnel syndrome diagnoses per 1,000 person-years, controlling for covariates. Using Poisson regression, we computed rate ratios for gender, using males as the referent, and controlling for differences in age, race, service, and rank between males and females. All statistical analyses were performed using SAS software (Statistical Analysis Software Institute, Cary, NC, USA).

Results

A total of 48,957 cases of carpal tunnel syndrome were documented in our population at risk of 12,298,088 person-years. The unadjusted incidence rate of carpal tunnel diagnoses in our population was 3.98 per 1,000 person-years.

In the evaluation of gender differences, females had a significantly higher incidence of CTS compared to males in this military population. The unadjusted incidence rate for males was 3.09 per 1,000 person-years, compared with 8.69 for females. The adjusted incidence rate ratio, controlling for race and age, with males as the referent category, was 3.29 (95% confidence intervals (CI), 3.23, 3.35; $p<0.0001$; Table 1).

Age also had a significant effect on the incidence of CTS, with older patients having a greater rate of diagnosed CTS. The highest incidence rate was seen in the ≥40-year-old group with an incidence rate of 9.08 per 1,000 person-years. The adjusted incidence rate ratio for the ≥40-year-old group with the <20-year-old group as the referent category was 11.63 (95% CI, 10.90, 12.41). As shown in Table 2 and Fig. 1, the incidence trend increases by age group in a nearly linear fashion.

Rank was evaluated as an estimated measure of occupational type since enlisted personnel and lower-ranked individuals tend to perform more manual labor occupations than do higher-ranked personnel and officers. Analysis by rank showed that this factor was significant in its effect on CTS incidence, independent of age and gender. The highest rates were seen in the senior enlisted (5.56 per 1,000 person-years) and senior officer (4.98 per 1,000 person-years) groups, with the lowest rates in junior officers. A complete listing of all rank effects is in Table 3.

Table 1 Incidence of carpal tunnel syndrome segregated by gender.

Group	Incidence rate (per 1,000 person-years)	Adjusted rate ratio[a] (95% confidence intervals)
Male	3.09	Referent
Female	8.69	3.29 (3.23, 3.35)

[a] Rate ratio adjusted for age, gender, and race

Table 2 Incidence of carpal tunnel syndrome by age group.

Age group (years)	Incidence rate (per 1,000 person-years)	Adjusted rate ratio[a] (95% confidence intervals)
<20	1.32	Referent
20–24	2.53	2.05 (1.93, 2.17)
25–29	3.37	3.19 (3.00, 3.39)
30–35	3.98	4.36 (4.09, 4.65)
35–39	6.32	7.19 (6.75, 7.67)
≥40	9.08	11.63 (10.90, 12.41)

[a] Adjusted for gender, race, and rank

Table 3 Incidence of carpal tunnel syndrome segregated by rank.

Group	Incidence rate (per 1,000 person-years)	Adjusted rate ratio[a] (95% confidence intervals)
Junior enlisted (E1-E4)	2.83	1.53 (1.47, 1.59)
Senior enlisted (E5-E8)	5.56	3.18 (3.06, 3.30)
Junior officer (O1-O3)	2.36	Referent
Senior officer (O4-O9)	4.98	2.72 (2.60, 2.85)

[a] Rate ratio adjusted for age, gender, and race

Discussion

The epidemiology of CTS has been studied previously, mainly in region-specific studies, using a variety of criteria. Reported incidence rates have varied from 1.8 per 1,000 person-years in studying diagnosed CTS in general practices in the Netherlands [4] up to a calculated incidence of 38 per 1,000 person-years in a questionnaire study in southern Sweden, confirmed by examination of symptomatic responders [2]. In the US, a study from the Epidemiology Program Project in Rochester, Minnesota showed an incidence of CTS of 0.99 per 1,000 person-years over a 19-year period in a small city. A more recent chart review in a health maintenance organization (HMO) in Wisconsin demonstrated an incidence of probable or definite CTS of 3.5 per 1,000 person-years, using ICD-9 coding diagnoses [12] (Table 4).

We determined the rate of CTS in the US military population to be 3.98 per 1,000 person-years, which is greater than these previous general population reports. This disproves our hypothesis for this study, as our theory was that a predominantly young military population would have a lower incidence of CTS than that seen in civilian populations. The criteria for the diagnosis of CTS in this database are provider-based, without objective electrodiagnostic data or standardized physical examination findings, similar to the Wisconsin HMO study [12]. Other studies have based the diagnosis of CTS on specific physical findings [1] or electrophysiologic data [10].

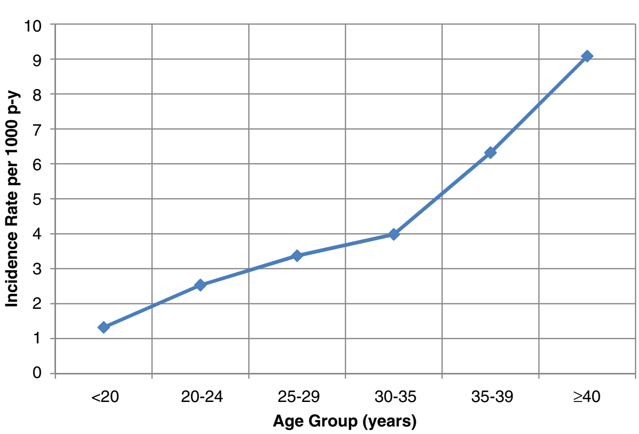

Figure 1 Incidence rate of carpal tunnel syndrome by age group.

The greater incidence of CTS in women, as demonstrated in our study, has been previously noted. A study in an Italian population which identified patients through the records of four electromyographic centers in Siena showed a CTS incidence of 5.1 per 1,000 person-years for women compared to 1.4 for males, a ratio of 3.6:1 [10]. The investigators noted that incidence in women increased by age up to the 50–59-year age group, then declined, while males showed a bimodal distribution with peaks in the 60s and 80s. Bongers et al. [4] similarly showed a nearly 3:1 ratio of CTS incidence captured by diagnostic codes in a general population in the Netherlands (females 2.8 per 1,000 person-years, males 0.9 per 1,000 person-years).

Evaluation of CTS occurrence by age group in general populations has shown peak incidence in the years 40–59 in several studies [1, 10, 12, 15]. Bland and Rudolfer noted a bimodal age distribution with peaks in the groups of 50–54 and 75–84 years [3]. There have been few studies of CTS in younger populations. Vessey et al. reported on the epidemiology of CTS in women of childbearing age presenting to contraceptive clinics, with an estimated incidence of 1.5 per 1,000 person-years. These investigators noted that diagnosis rates of CTS increased with age, tobacco use, and duration of oral contraceptive use [18]. Another group noted that diagnostic clinical and electrophysiologic tests were negative in the majority of a group of patients under 35 years with clinical symptoms of CTS and response to surgery, when compared to a cohort over 35 years, suggesting that this group is underdiagnosed and treated for CTS [13].

While CTS has been studied previously in the military, the populations studied were specific occupational groups or service members. A study of CTS prevalence in dental personnel in the army, using questionnaire responses, showed a probable diagnosis of CTS in 25% of 5,115 responders [9]. A larger study of enlisted Navy personnel over 8 years, using a database, indicated an overall CTS incidence of 0.12 per 1,000 person-years, with a significantly higher proportion of females [7]. Our study encompassed

Table 4 Epidemiology of CTS in the literature.

Study author and year	Type of population/study	Incidence rate of CTS (per 1,000 person-years)
Stevens et al. 1988	Rochester, Minnesota population—database	0.99
Vessey et al. 1990	Women referred to family planning clinics with diagnosed CTS	0.15
De Krom et al. 1991	Maastricht, Netherlands—questionnaire, examination, and electrophysiologic testing (EMG)	3.35
Garland et al. 1996	Enlisted naval personnel—database	0.12
Nordstrom et al. 1998	Marshfield, Wisconsin HMO database	3.38
Atroshi et al. 1999	Scania, Sweden—questionnaire and examination	3.81
Solomon et al. 1999	New Jersey Medicare/Medicaid population who had carpal tunnel surgery	2.72
Mondelli et al. 2002	Italian general population—EMG confirmed CTS	3.29
Bongers et al. 2003	General practice data in the Netherlands—2001 population data denominator	1.84
Bland et al. 2003	East Kent, UK—EMG-confirmed CTS	0.95
Gell et al. 2005	Longitudinal study of workers at industrial and clerical sites	2.49
Roquelaure et al. 2008	Working population of Loire, France, with EMG-confirmed CTS	1.00
Current study	US military population	3.98

all four services, including all ranks and geographic locations, and found a higher overall CTS incidence of nearly four per 1,000 person-years. Our investigation noted a similar finding of female predominance of CTS, with an incidence rate ratio of 3.29 for females as compared to males. In a predominantly young population, we showed that CTS incidence increases nearly linearly with age (Fig. 1).

We studied military rank as a variable because it provides a crude measure of occupational work, with the broad assumption that lower-ranked enlisted personnel tend to perform more manual labor, while higher-ranked and officer status personnel may tend to perform less physical labor and more "white-collar"-type work. Analysis of our data demonstrated significantly higher incidence rate ratios of CTS in senior enlisted (E-5 to E-9) and senior officer (O-5 to O-9) groups. This may reflect the wide diversity of occupation within rank and also the recent reports that heavy keyboard use and pinch grip at work were not associated factors in CTS [2, 11]. Service members with higher rank also tend to be older with more time in service, and this may have a correlation with the finding that increased age in this population showed increasing numbers of diagnosed CTS.

The primary limitation of this study is the use of ICD-9 diagnostic coding for CTS, which is based on provider synthesis of history and physical examination findings to provide a billing diagnosis of CTS, with or without electro-diagnostic tests. The diagnosis of CTS can be entered by a primary care or specialty provider, with the corresponding weakness of variable medical background and training in the diagnosis of this nerve compression syndrome. Specific history and physical examination findings are not available within these data and thus cannot be used to standardize the diagnostic criteria for CTS. The data do not include procedural codes, so it is not possible to correlate diagnoses with objective electrodiagnostic data. Rempel et al. [14] noted that, while the combination of clinical symptom characteristics with electrodiagnostic data provided the highest accuracy in the diagnosis of CTS, classic symptoms and physical examination findings provided good diagnostic information for use in epidemiologic studies. Another limitation of this database study is that specific data on occupation, time in service, and surgical treatment were not available for correlation.

The US military is composed of primarily young and active individuals. The finding of an overall incidence of CTS of nearly four per 1,000 person-years was unexpected since previous studies of CTS in general populations show peaks in the fourth and fifth decades [5, 6]. A potential explanation for this finding is that the population of over 12 million person-years is one of the largest to date for an epidemiologic evaluation of CTS and may reflect higher clinical recognition or diagnosis of milder cases. Another explanation for this relatively high incidence is that the diagnosis of CTS is based on provider diagnosis without specific examination findings or electrodiagnostic data and may include incorrect coding for CTS, thus overestimating the incidence in the military population.

Other investigators have noted an increase of CTS incidence over time [12, 17], as shown by a significant increase in cases of CTS in Canterbury, England between 1992 and 2001 [3]. In this study, we noted no differences in diagnosis rates when analyzed by year during the time period from 1998 to 2006.

In summary, this analysis of CTS in the US military showed an overall incidence of 3.98 cases per 1,000 person-year, with significant female predominance. The CTS incidence increased almost linearly with age in this young population, and higher-ranked enlisted personnel and officers were at greater risk for CTS. This study's findings indicate an increasing awareness of CTS among providers in the military population. The next step is an analysis by occupation within this group in order to identify persons at high risk because of their jobs.

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