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Prostate cancer incidence in Air Force aviators compared with non-aviators

David Rogers, MD, MPH[1], **Douglas D. Boyd, Ph.D.**[2,7], **Erin E. Fox, Ph.D.**[3], **Sharon Cooper, Ph.D.**[4], **Marc Goldhagen, M.D.**[1], **Yu Shen, Ph.D.**[5], and **Deborah J. del Junco, Ph.D.**[6]

[1]United States Air Force (USAF) School of Aerospace Medicine, Wright-Patterson AFB, OH [2]Department of Cancer Biology, MD Anderson Cancer Center, Houston, TX; dboyd@mdanderson.org [3]Center for Clinical and Translational Sciences, University of Texas Health Science Center at Houston, Houston, TX; Erin.E.Fox@uth.tmc.edu [4]School of Public Health, University of Texas Health Science Center at Houston, Houston TX. Sharon.P.Cooper@uth.tmc.edu [5]Biostatistics, MD Anderson Cancer Center, Houston, TX, yshen@mdanderson.org [6]Department of Surgery and Center for Translational Injury Research, University of Texas Health Science Center at Houston, Houston, TX; Deborah.J.delJunco@uth.tmc.edu

Abstract

Introduction—Several studies investigating whether prostate cancer incidence is elevated in aviators both in the civilian and military sectors have yielded inconsistent findings. Most investigations have compared aviators to the general population. Instead, our study compared prostate cancer incidence rates among officer aviator and non-aviators in the United States Air Force to reduce confounding by socioeconomic status and frequency of medical exams.

Methods—This retrospective analysis ascertained prostate cancer cases using the Automated Cancer Tumor Registry of the Department of Defense linked to personnel records from the USAF Personnel Center to identify aviators and non-aviators. Survival analysis using the Cox Proportional Hazards model allowed comparison of prostate cancer incidence rates in USAF aviators and non-aviators.

Results—After adjustment for age and race, the hazards ratio for prostate cancer incidence comparing aviators with non-aviators was 1.15 (95 % confidence interval, 0.85-1.44). Neither prostate cancer incidence nor time to diagnosis differed significantly between the two groups.

Conclusion—Our study compared prostate cancer rates in aviators with a reference group of non-aviators similar in socio-economic level and frequency of exams. When compared to this internal reference group the risk of prostate cancer in USAF officer aviators appeared similar with no significant excess.

Keywords

genitourinary malignancy; pilots; tumor

INTRODUCTION

Exposure to the flight environment has been listed as a risk factor for prostate cancer based on several epidemiologic studies with civilian and military aviators (2,3,11). However,

[7]To whom all correspondence should be sent: dboyd@mdanderson.org .

findings from these studies have been inconsistent. While the majority of studies using standardized incidence ratios (SIR) and standardized mortality ratios (SMR) reveal a statistically significant increase in prostate cancer incidence among aviators, other studies show no difference. For example, Band et al (3) analyzed Air Canada pilots for cancer incidence and found an elevated SIR for prostate cancer of 1.87 (90% confidence interval (CI): 1.38-2.49). Nicholas and co-workers identified a slightly increased mortality due to this malignancy among US commercial pilots, 1.46 (95% CI: 1.06-2.03) (8) using, as reference, a population employed in a non-aviation field. Additionally, in a study of Nordic airline pilots (9), aviators were reported to carry a slight excess risk of 1.21 (95% CI: 0.93-1.54) for this malignancy although the confidence intervals crossed unity. In the same study, the authors also compared prostate cancer rates in pilots based on differences in flying hours and calculated an increased relative risk (RR) of 3.38 (95% CI: 1.26-11.9) for aviators with >10,000 flying hours using a reference group with <5,000 flying hours. Lastly, in an analysis of prostate cancer incidence in the USAF, Shurlow reported a 2.4 fold increased risk for aviators in fighter airframes compared with those in non-fighter airframes (e.g. bomber, transport aircrew) (10). However, accurate person-time at risk data were lacking in that study. On the other hand, Gundestrup and Storm (6) found no elevated incidence of this malignancy (SIR=0.8) among Danish civilian aviators.

Thus, the data supporting the postulate that prostate cancer incidence in aviators is elevated are inconsistent. This lack of consistency between the various studies may reflect the discordant populations used. For example, comparison of aviators with the general population does not take into consideration socioeconomic status (SES), which is a risk factor for prostate cancer (7). Pilots are considered to have higher SES based on education and pay scale and therefore potential confounding by SES should be considered. Second, unlike the general population, aviators are subject to annual mandatory physicals raising the possibility that increased diagnostic activity could be a contributing factor to elevated incidence rates. Indeed, in a study where two reference groups were used (5), testicular cancer incidence rates among aviators were the same as the rates for the internal standard (USAF non-flying officers) whereas the rates among aviators appeared elevated compared with the external standard (civilians). Prostate cancer incidence rates were not calculated for that study. With this in mind, we undertook a retrospective study to compare prostate cancer incidence rates in two USAF officer cohorts: aviator and non-aviator. In the USAF annual physicals for all personnel are mandatory as per the Department of Defense Health Affairs Policy (06-006) and Air Force Instruction document AFI 48-123 thus removing diagnostic surveillance as a confounder in our study.

METHODS

Data Collection

Institutional Review Board approval was obtained from the USAF 711th Human Performance Laboratory, the Armed Forces Institute of Pathology, MD Anderson Cancer Center, and the University of Texas Health Science Center. Data from active duty USAF personnel, who were diagnosed with prostate cancer, were identified in the Automated Cancer Tumor Registry (ACTUR), a centralized Department of Defense (DoD) cancer registry, required for use in uniformed services medical treatment facilities. A prostate cancer diagnosis is confirmed in ACTUR based on biopsy results (Tryon J. Personal Communication–ACTUR Tumor Registrar). We queried this database for prostate cancer cases diagnosed during active duty between the years 1987 and 2008. Data obtained from ACTUR included social security number (SSN), service branch, and date of prostate cancer diagnosis. These cases were then deterministically linked by SSN to USAF Personnel Center (AFPC) data to identify which cases corresponded to Officers. The cohort of prostate cancer cases in Officers was thereafter divided into aviators/non-aviators again using AFPC data.

The control group (non-aviator cohort) consisted of Officers with less than 200 h flight time accrued in USAF aircraft (data provided by the AFPC). The AFPC also provided information, by SSN, date of entry into active duty, number of flying hours (used to define aviator status), and date of separation or retirement from active duty for those who left service during the study period. Finally, the AFPC provided data on the denominator population (i.e. active duty men without prostate cancer).

Statistical analysis

We used survival analysis techniques to compare aviator and non-aviator groups. To be eligible for the "at risk cohort" for the survival analysis, records had to have valid, complete data for the following variables: date of birth, date of entry to active duty military, and date of follow-up (defined as either the date of prostate cancer diagnosis, the date of separation from active duty, or Dec 31, 2008, whichever occurred first and after the individual's 35th birthday). Entry into the cohort was defined by either the date of the individual's 35th birthday or the date of his entry into active duty, whichever was more recent. Follow-up ended at whichever of the following dates occurred first: the date of prostate cancer diagnosis, the 70th birthday, separation from active duty, or Dec 31, 2008.

The records of prostate cancer cases were linked by SSN to data obtained from the AFPC to determine history of aviation duties. A subject was identified as an aviator if he had more than 200 hours of flying time accrued in any USAF aircraft. Aviation duties included pilot, navigator, weapons systems officer, flight surgeons, air battle manager, and other career fields which require frequent flight on-board USAF aircraft. The control group (non-aviator cohort) consisted of Officers with less than 200 hours flight time accrued in USAF aircraft.

Person-time at risk was calculated and cohorts were merged in SAS v9.1 (SAS Institute Inc., Cary, NC). Starting time was set at the subject's 35th birthday or when entered active duty if after age 35. For cases, the date of last follow-up was the date of prostate cancer diagnosis as entered into ACTUR. For those without cancer, the date of last follow-up was their USAF separation date or the date the study ended, Dec 31, 2008. Statistical analysis for Cox proportional hazards models and time to diagnosis were performed on Stata 10.1/IC (Stata Corp. College Station, TX). Multivariable Cox models included age (continuous) or age and race (white vs. others) as confounders.

RESULTS

A total of 169,078 USAF male officer records were identified, of which 106,418 were used in the study cohort because they fell within the study entry and follow-up dates. Those excluded from the cohort were officers who were on active duty but separated prior to age 35. Using the study definition of aviator (>200 career flying hours), 61,844 were considered career aviators. Population characteristics of this dynamic cohort are as per Table I and II. The total analysis time-at-risk was 965,967 person-years (Table II). All active duty men were assumed to be free of a prostate cancer diagnosis upon entry to the cohort and the cohort was followed for prostate cancer incidence diagnosed between 1987 and 2008.

One hundred ninety-nine records were matched by SSN to ACTUR, meaning that by report, these active duty officers were diagnosed with prostate cancer between 1987 and 2008. Of the 199 cases, 37 % were aviators and 63 % were non-aviators. The mean age at diagnosis of both aviators and non-aviators with prostate cancer was almost identical (50.4 ± 5.7 and 50.3 ± 5.6 years respectively) and not significantly different (Student T-test; p=0.956, t = −0.06, degrees of freedom=197). Race demographics for aviators with prostate cancer showed a preponderance of Caucasian men (96%) with the remaining men (4%) being African American. Of the non-aviators with prostate cancer, 15.9% were African American. A Chi square test for race of prostate cancer cases who were aviators compared with cases who were non-aviators revealed a significant difference (p=0.003, Chi square=10.44, degrees of freedom=4).

The average number of flying hours among the aviators who had prostate cancer was 3,052 hours (standard deviation (SD) 1,367), while for aviators without prostate cancer the average flight time was 2,625 hours (SD 1,447), (t(61,842)=2.52, p=0.0118).

Using the Cox proportional hazards model, the hazards ratio (HR) was 1.07 between aviators and non-aviators (95% CI: 0.80-1.44) when adjusted for age. When adjusted for both age and race, the HR was 1.15 (95% CI: 0.85-1.56). Additionally, the time to prostate cancer diagnosis indicated (Figure 1) no difference between the two cohorts with large confidence intervals at the longer times (20-25 years) reflecting few cases.

Although the number of prostate cancer cases was small, we also determined whether prostate cancer risk was associated with flight time. A Cox regression analysis of the subgroups of aviators comparing those with >3,000 flying hours to those with <1,500 (thus providing a 2 fold contrast similar to a previous study of pilots (9)) was undertaken adjusting for race and age. A hazards ratio of 1.49 (95 % CI: 0.76-2.94) was calculated although this ratio was statistically non-significant (p=0.25).

DISCUSSION

Our findings suggest that USAF aviators do not carry an excess risk of prostate cancer compared to a reference group of comparable socioeconomic status and access to health care. To our knowledge, ours is the first study to compare prostate cancer incidence rates in aviators using a comparison group of similar socioeconomic level and also subject to annual physical exams. The difference in our findings compared with other reports may reflect, in a large part, the fact that other studies typically use the general population as a reference group.

However, caution should be exercised in extrapolating our findings with USAF pilots to similar reports for civilian pilots. Thus, there is a real difference in flight hours and the type of flying by these two groups. Specifically, USAF pilots accrue fewer flying hours and fly at lower altitudes compared with long-haul commercial aircrew. The latter flights are not only of longer duration but may also include polar routes, which yield higher cosmic radiation exposure (1). Indeed, the study by Pukkala (9) found an increased relative risk for prostate cancer in long-haul pilots: 3.88 for aviators with >10,000 hours compared with pilots with <5,000 hours. Whether this increase is due in part to the finding of increased chromosomal translocations in pilots with long-term flying (12), or to other factors or confounders, remains to be determined. In contrast, the average career flying hours in the USAF aircrew from our study were less than 3,000 h.

It is also worth mentioning that our study group consisted of a much younger prostate cancer population whose average age at diagnosis was 50 years. This reflects the fact that 90% of USAF officers retire by the age of 50. In contrast, in the US general population, >70% of all prostate cancer cases are diagnosed after age 65 (4). It would be of interest, in future studies, to track patients beyond active duty (i.e. in retirement) to determine if our results hold in the older age groups.

In conclusion, our data suggest that USAF aviators do not carry an excess risk of prostate cancer while on active duty when compared with a control group of similar socioeconomic status and also subject to annual physicals. Nevertheless, considering that prostate cancer is slow growing and may be clinically asymptomatic for many years, further studies are warranted to follow airmen after their separation/retirement from the USAF for the development of this malignancy.

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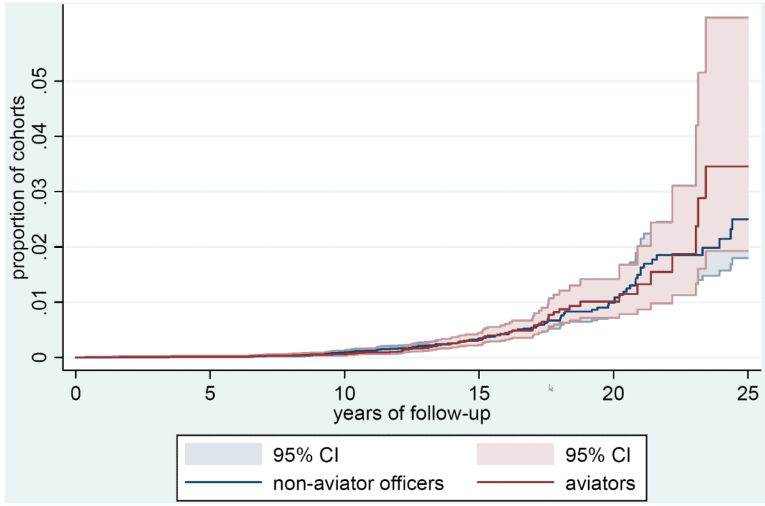

Figure 1.
Time to Diagnosis of prostate cancer.

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Table I

Population Characteristics.

	n	% with prostate cancer	Flight Hours	Age at Diagnosis (mean ± SD)	Caucasion % (n)	African American % (n)	Native American	Pacific Islander/Native Hawaiian	Unknown	No Data
Aviators (>200 h) with prostate cancer.	73	0.118	3,052 ± 1,367	50.4 ± 5.7	96 (70)	4 (3)	0	0	0	
Aviator Population-prostate cancer –	61,771		2,625 ± 1,447	N/A	94 (57,847)	2 (1,434)	0.8 (169)	0.1 (51)	2.8 (1,751)	
Non-Aviators with prostate cancer.	126	0.118	N/A	50.3 ± 5.6	79.4 (100)	15.9 (20)	0.8 (1)	0	4 (5)	
Non-Aviator Population-prostate cancer-free.	107,108		N/A	N/A	85.2 (91,267)	6.3 (6,757)	0.34 (368)	0.17 (184)	2.02 (2,162)	3.9 (4,185)

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Table II

Dynamic Cohort Characteristics.

	Person Years of Follow-up	n	Mean (Yr)	S.D.	p value	T-value	Degrees of freedom	Youngest Age (yr)	Oldest Age (yr)	Birth Year Range
Aviators	375,222	40,314	9.92	5.12	<0.0001	11.13	106,286	35	80	1923-1973
Non-Aviators	590,745	65,974	9.54	5.56				35	79	