Incident Diagnoses of Cancers and Cancer-related Deaths, Active Component, U.S. Armed Forces, 2000-2011

In the United States, cancer is one of the five leading causes of death in all age groups among both men and women; overall, approximately one in four deaths is attributable to cancer. Compared to the general U.S. population, military members have been estimated to have lower incidence rates of several cancers including colorectal, lung, and cervical cancers and higher rates of prostate, breast, and thyroid cancer. Between 2000 and 2011 in active component members of the U.S. military, crude incidence rates of most cancer diagnoses have remained stable. 9,368 active component service members were diagnosed with one of the cancers of interest and no specific increasing or decreasing trends were observed. Cancer is an uncommon cause of death among service members on active duty and accounted for a total of 1,185 deaths during the 12-year surveillance period.

Since 1998, in the United States, statistics regarding cancer incidence and cancer-related mortality among U.S. civilians have been published each year in the Annual Report to the Nation; the most recent report documents declining death rates due to all cancers in the period from 1999 to 2008 and decreasing incidence of prostate and colorectal cancers over the same period. Similar declining trends are evident for lung and breast cancers in general.[1] However, cancer remains a significant public health concern; cancer is one of the five leading causes of death in all age groups among both men and women, and approximately one in four deaths in the U.S. is attributable to cancer.[2]

Most studies of cancer incidence in military members have focused on specific cancers or a single service; the risk of developing cancer in a specific military occupational group (e.g., aviators) has also been examined. For example, Yamane investigated overall cancer incidence in the U.S. Air Force from 1989-2002. The findings indicated that the incidence of invasive cancers overall had significantly decreased during the 12-year period. Compared to the general U.S. population, standardized incidence ratios for all cancers were lower than expected among male Air Force members (0.50; 95% CI:0.48-0.53) and as expected among females (0.96; 95% CI:0.89-1.03). Standardized incidence ratios of cervical (3.19; 95% CI:2.74-3.70), prostate (1.44; 95% CI:1.21-1.69) and vulvar (3.54; 95% CI:1.77-6.28) cancers were significantly higher.[3] Zhu and colleagues compared incidence rates of six cancers (lung, colorectal, prostate, breast, testicular and cervical cancer) in active military and civilian populations. As in the Yamane study, cancer incidence among military members was determined using the Department of Defense Automated Central Tumor Registry (ACTUR); cancer incidence among U.S. civilians was estimated using data from the SEER (Surveillance, Epidemiology, and End Results) study of the National Cancer Institute. Compared to the general U.S. population, military members were estimated to have lower incidence rates of colorectal, lung, and cervical cancers and higher rates of prostate and breast cancers.[4] Most recently, Enewold and colleagues reported significantly higher incidence rates of thyroid cancer in white women and black men and women serving in the military as compared to the general U.S. population.[5]

In 2010, the *MSMR* reported on incidence rates of malignant melanoma and selected cancer diagnoses and cancer-related deaths from 2000-2009 in active component military members; in general, rates of diagnoses of the cancers of interest were relatively stable during that time period.[6] This report extends that analysis by summarizing numbers, rates and trends of incident diagnoses of melanoma and other selected cancers and by enumerating cancer-related deaths among active component military members through 2011.

METHODS

The surveillance period was 1 January 2000-31 December 2011. The surveillance population included all individuals who served in the active component of the U.S. Armed Forces at any time during the surveillance period. For deaths attributed to cancer, the surveillance population included all individuals who served in the active or reserve components of the U.S. Army, Navy, Air Force, Marine Corps, or Coast Guard during the surveillance period. All data used to determine incident cancer cases were derived from records routinely maintained in the Defense Medical Surveillance System (DMSS). Deaths of active duty service members were ascertained from records produced by Service-specific casualty offices and the Armed Forces Medical Examiner System, maintained in the DoD Medical Mortality Registry, and routinely provided for health surveillance purposes to the Armed Forces Health Surveillance Center (AFHSC).

For surveillance purposes, an incident case of malignant melanoma was defined as (a) two or more medical encounters with diagnoses of "malignant melanoma" in the first diagnostic position (ICD-9-CM codes: 172.0-172.9) following at least one medical encounter with a diagnostic procedure commonly used to evaluate clinically suspicious lesions; or (b) five or more medical encounters with diagnoses of "malignant melanoma" in the first diagnostic position (if there are no reported relevant diagnostic procedures).

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14. ABSTRACT

In the United States, cancer is one of the fi ve leading causes of death in all age groups among both men and women; overall, approximately one in four deaths is attributable to cancer. Compared to the general U.S. population military members have been estimated to have lower incidence rates of several cancers including colorectal, lung, and cervical cancers and higher rates of prostate, breast, and thyroid cancer. Between 2000 and 2011 in active component members of the U.S. military, crude incidence rates of most cancer diagnoses have remained stable. 9,368 active component service members were diagnosed with one of the cancers of interest and no specifi c increasing or decreasing trends were observed. Cancer is an uncommon cause of death among service members on active duty and accounted for a total of 1,185 deaths during the 12-year surveillance period.

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Diagnostic procedure codes indicative of malignant melanoma are listed in a previous *MSMR* report.[7] For other cancer diagnoses, incident cases were defined as either one inpatient encounter with a defining diagnosis in the first diagnostic position (or in the second diagnostic position if the first code was a V-code indicating radiotherapy or chemotherapy treatment [ICD-9-CM:V58.0-V58.12]) or three or more outpatient encounters within a 90-day period with the defining diagnosis in the first or second diagnostic position.

The following ICD-9-CM codes were used to define cases of selected cancers by the affected anatomic site or cell type: malignant neoplasm of the colon and rectum: 153.0-154.1, 159.0; malignant neoplasm of the lung and bronchus: 162.2-162.9; malignant neoplasm of the female breast: 174.0-174.9; cervical cancer: 180.0-180.9; prostate cancer: 185; malignant neoplasm of testis: 186.0-186.9; malignant neoplasm of the brain: 191.0-191.9; non-Hodgkin lymphoma: 200.0-200.8, 202.0-202.2, 202.8-202.9; leukemia: 204.0-208.9. Summaries of cancer-related deaths include a category of "other." The "other" category included all sites of cancers that accounted for fewer than 60 deaths each during the 12-year period: gastrointestinal (n=59), head and neck (n=52), urinary (n=45), bone and joint (n=31), Hodgkin lymphoma (n=21), testicle (n=17), mesothelium (n=26), prostate (n=9), and cervical and other gynecologic (n=7) **(data not shown)**.

For surveillance purposes, incident dates of cancer diagnoses were the dates of the first medical encounters of affected individuals that included case-defining diagnoses. Individuals could be counted as incident cancer cases only once during the surveillance period (even if cases had diagnoses of more than one cancer type, recurrences of previously treated cancers, or metastatic lesions of primary cancers). Military members with case-defining cancer diagnoses prior to the start of the surveillance period were excluded from the analysis (because they were not considered at risk of incident [first-ever] cancer diagnoses during the period). However, any death attributed to cancer that occurred during the surveillance period was counted, although in some cases, the initial diagnosis of cancer for those individuals may have occurred before the beginning of the surveillance period.

RESULTS

During the 12-year surveillance period, 9,368 active component members were diagnosed with at least one of the cancers of interest for this report. Over the 12-year period, the crude rate of incident diagnoses of the subject cancers was 55.2 per 100,000 person-years (p-yrs); the lowest annual incidence rate was 50.3 per 100,000 p-yrs in 2003, and the highest annual incidence rate was 60.1 per 100,000 p-yrs in 2009 **(Figure 1)**.

From January 2000 through December 2011, the numbers of incident diagnoses of non-gender-specific cancers were malignant melanoma (n=1,788), non-Hodgkin lymphoma (n=1,197), colorectal cancer (n=762), brain cancer (n=748), leukemia (n=530), and cancer of the lung/bronchus (n=274). Among males, the most frequent cancer diagnoses were testicular cancer (n=1,832), malignant melanoma (n=1,499), and prostate cancer (n=1,263); among females, the most frequent cancer diagnoses were breast cancer (n=874), malignant melanoma (n=289), and non-Hodgkin lymphoma (n=148) **(Table 1, Figure 1)**. There were no clear trends of increasing or decreasing cancer diagnosis incidence – of specific sites or overall **(Figures 1, 2a, 2b)**.

In general, the strongest demographic correlate of increased risk of a cancer diagnosis was older age. For example, for all cancer sites except the cervix and testicle, the highest rates of diagnoses were among those older than 40 years **(Table 1)**. For most cancers examined, crude incidence rates were lower among members of the Marine Corps than the other Services. Military members in health care occupations had relatively high rates of several cancers; the relatively highest cancer-specific incidence rates (unadjusted) among health care workers (compared to those in combat-specific occupations) were for prostate (RR: 2.86), female breast (RR: 1.95), and lung (RR: 1.49) cancers **(Table 1)**.

Consistent with published literature, the incidence rate for prostate cancer in black males was about twice that observed in white males; however, black males had much lower crude incidence rates

FIGURE 1. Incident diagnoses of selected cancers and total incidence rate, by year and affected anatomic site/cell type, active component, U.S. Armed Forces, 2000-2011

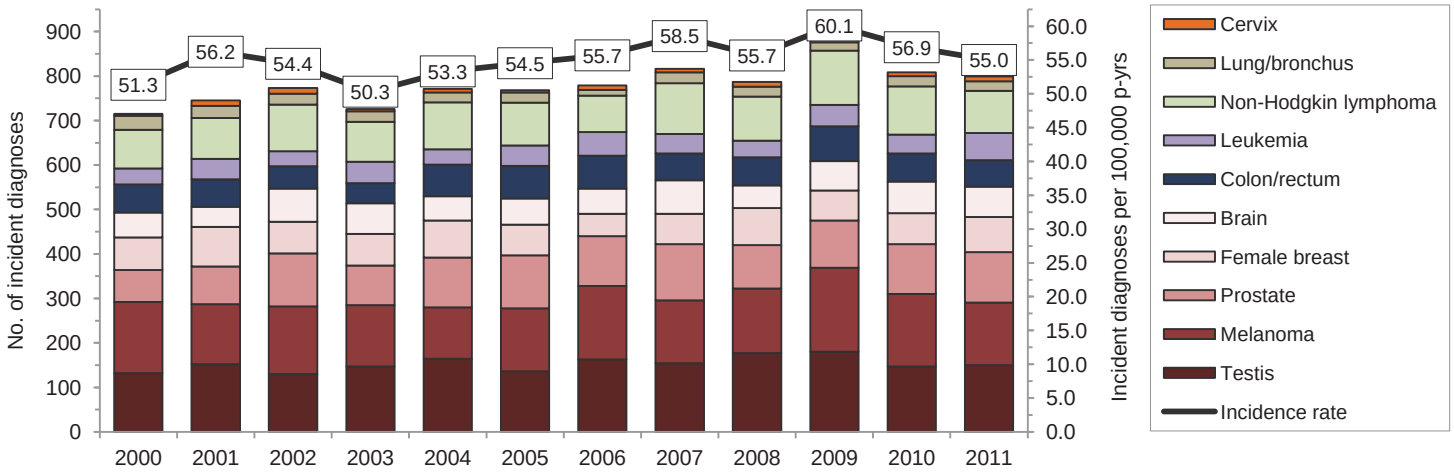


TABLE 1. Numbers and rates of incident diagnoses of selected cancers, by demographic and military characteristics, active component, U.S. Armed Forces, 2000-2011

	Malignant melanoma			Colorectal			Lung/bronchus			Brain/other central nervous system			Non-Hodgkin lymphoma		
	No.	Rate[a]	RR	No.	Rate[a]	RR	No.	Rate[a]	RR	No.	Rate[a]	RR	No.	Rate[a]	RR
Total	1,788	10.5		762	4.5		274	1.6		748	4.4		1,197	7.0	
Service															
Army	523	8.6	ref	266	4.4	ref	95	1.6	ref	266	4.4	ref	416	6.8	ref
Navy	470	11.2	1.31	201	4.8	1.10	85	2.0	1.30	169	4.0	0.92	299	7.1	1.04
Air Force	633	15.5	1.81	206	5.1	1.16	60	1.5	0.94	205	5.0	1.15	334	8.2	1.20
Marine Corps	162	7.3	0.85	54	2.4	0.56	27	1.2	0.78	89	4.0	0.92	117	5.3	0.78
Coast Guard	0	0.0	0.00	35	7.4	1.71	7	1.5	0.96	19	4.0	0.93	31	6.6	0.97
Sex															
Male	1,499	10.3	ref	660	4.5	ref	236	1.6	ref	648	4.4	ref	1,051	7.2	ref
Female	289	11.7	1.14	102	4.1	0.91	38	1.5	0.95	100	4.1	0.91	146	5.9	0.82
Race/ethnicity															
White, non-Hispanic	1,659	15.5	ref	490	4.6	ref	179	1.7	ref	561	5.2	ref	774	7.2	ref
Black, non-Hispanic	9	0.3	0.02	164	5.5	1.22	54	1.8	1.10	86	2.9	0.56	223	7.5	1.05
Other	120	3.6	0.23	108	3.2	0.71	41	1.2	0.73	101	3.0	0.58	200	6.0	0.83
Age															
<20	13	1.0	ref	2	0.2	ref	5	0.4	ref	28	2.2	ref	43	3.4	ref
20-24	192	3.4	3.27	47	0.8	5.20	28	0.5	1.24	170	3.0	1.34	281	5.0	1.45
25-29	287	7.7	7.44	78	2.1	13.14	21	0.6	1.41	154	4.1	1.85	220	5.9	1.72
30-34	288	11.6	11.18	110	4.4	27.73	26	1.0	2.62	121	4.9	2.18	164	6.6	1.92
35-39	374	17.4	16.76	161	7.5	46.85	47	2.2	5.47	139	6.5	2.89	203	9.4	2.75
40+	634	35.6	34.27	364	20.4	127.70	147	8.2	20.61	136	7.6	3.41	286	16.0	4.67
Military grade															
Enlisted	987	6.9	ref	516	3.6	ref	210	1.5	ref	580	4.1	ref	901	6.3	ref
Officer/other	801	28.9	4.18	246	8.9	2.45	64	2.3	1.57	168	6.0	1.49	296	10.7	1.69
Military occupation															
Combat	419	11.9	ref	152	4.3	ref	55	1.6	ref	168	4.8	ref	246	7.0	ref
Health care	217	15.7	1.32	76	5.5	1.28	32	2.3	1.49	71	5.1	1.08	135	9.8	1.40
Other	1,152	9.5	0.80	534	4.4	1.02	187	1.5	0.99	509	4.2	0.88	816	6.7	0.97

	Leukemia			Female breast[b]			Cervix[b]			Prostate[b]			Testicle[b]		
	No.	Rate[a]	RR	No.	Rate[a]	RR	No.	Rate[a]	RR	No.	Rate[a]	RR	No.	Rate[a]	RR
Total	530	3.1		874	35.6		100	4.1		1,263	8.7		1,832	12.6	
Service															
Army	207	3.4	ref	321	37.0	ref	42	4.8	ref	532	10.2	ref	586	11.3	ref
Navy	118	2.8	0.83	187	30.5	0.82	20	3.3	0.67	283	7.9	0.78	468	13.1	1.16
Air Force	137	3.4	0.99	325	41.4	1.12	30	3.8	0.79	338	10.3	1.01	458	14.0	1.24
Marine Corps	54	2.4	0.72	24	17.5	0.47	4	2.9	0.60	64	3.1	0.30	249	12.1	1.07
Coast Guard	14	3.0	0.88	17	31.0	0.84	4	7.3	1.50	46	11.1	1.09	71	17.2	1.53
Sex															
Male	466	3.2	ref	na	na	na	na	na	na	1,263	8.7	na	1,832	12.6	na
Female	64	2.6	0.81	874	35.6	na	100	4.1	na	na	na	na	na	na	na
Race/ethnicity															
White, non-Hispanic	350	3.3	ref	437	35.8	ref	63	5.2	ref	748	7.9	ref	1,423	15.0	ref
Black, non-Hispanic	71	2.4	0.74	300	43.2	1.21	15	2.2	0.42	382	17.0	2.15	64	2.8	0.19
Other	109	3.3	1.00	137	25.4	0.71	22	4.1	0.79	133	4.8	0.60	345	12.3	0.82
Age															
<20	33	2.6	ref	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00	66	6.4	ref
20-24	128	2.3	0.86	21	2.4	ref	9	1.0	ref	3	0.1	ref	502	10.5	1.65
25-29	83	2.2	0.85	46	8.1	3.39	18	3.2	3.10	6	0.2	3.04	515	16.4	2.58
30-34	91	3.7	1.39	112	33.8	14.17	26	7.9	7.68	11	0.5	8.17	356	16.6	2.61
35-39	78	3.6	1.38	197	78.7	32.97	32	12.8	12.50	50	2.6	42.12	238	12.6	1.98
40+	117	6.6	2.49	498	233.8	97.95	15	7.0	6.88	1,193	77.0	1,224.66	155	10.0	1.57
Military grade															
Enlisted	417	2.9	ref	533	26.1	ref	74	3.6	ref	548	4.5	ref	1,477	12.1	ref
Officer/other	113	4.1	1.39	341	82.0	3.14	26	6.3	1.72	715	30.6	6.80	355	15.2	1.25
Military occupation															
Combat	104	2.9	ref	43	26.4	ref	5	3.1	ref	246	7.3	ref	452	13.5	ref
Health care	52	3.8	1.28	241	51.6	1.95	17	3.6	1.18	190	20.9	2.86	126	13.9	1.03
Other	374	3.1	1.05	590	32.3	1.22	78	4.3	1.39	827	8.1	1.10	1,254	12.2	0.91

[a]Incident diagnoses per 100,000 p-yrs of military service
[b]For gender-specific cancers, rates as based on p-yrs of service of the respective gender only

of testicular cancer than other race/ethnic groups. As found in previous analyses, the crude rate of malignant melanoma was higher among white, non-Hispanic than other racial/ethnic groups **(Table 1)**.[4]

During the period, cancers accounted for 1,185 deaths of service members on active duty; this included service members in the active and reserve components **(Figure 3a, 3b)**. The number of cancer-related deaths per year markedly varied during the period; the fewest and most deaths per year for members of the active component were in 2000 (n=44) and 2009 (n=81). The cancers (by affected organ system or cell) that caused the most deaths during the period were lung/bronchus (n=129), brain/other central nervous system (n=130), and colon/rectum (n=124); however, the category with the most cancer deaths overall was that classified as "other" (n=132) **(Figure 3a).**

FIGURE 2a. Incidence rates of of selected cancers in males, active component, U.S. Armed Forces, 2000-2011

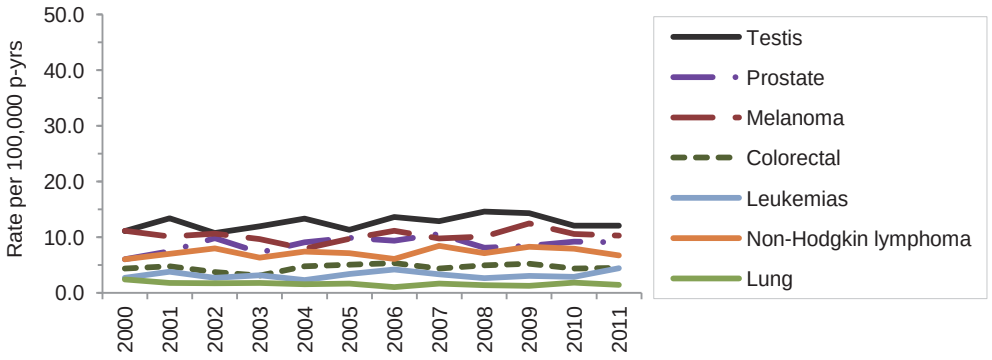
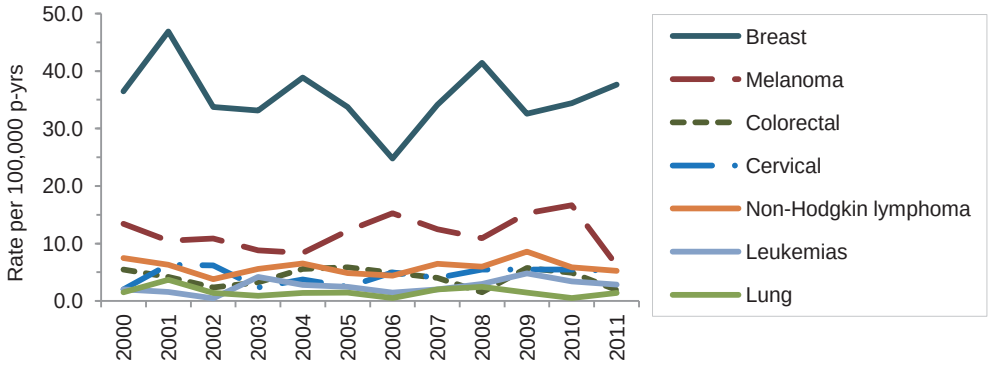


FIGURE 2b. Incidence rates of of selected cancers in females, active component, U.S. Armed Forces, 2000-2011



EDITORIAL COMMENT

Over the past twelve years, rates of diagnoses of the cancers of interest for this report have been stable among active component members of the U.S. military.

There are limitations to the analyses that should be considered when interpreting the results. For example, for this surveillance report, cancer cases were ascertained from ICD-9-CM coded diagnoses reported on standardized records of hospitalizations and outpatient medical encounters. As such, cancer diagnoses were not independently confirmed as with pathology reports or records in cancer registries (as was done to ascertain cases for some previous studies in military populations). As a result, some cancer-specific diagnoses considered case-defining for this report may reflect erroneous or miscoded diagnoses (e.g., some "rule out" or suspected cases may have been reported with cancer-specific codes). Because of the potential lack of specificity of cancer diagnoses on administrative medical encounter records, cancer cases reported herein may overestimate the actual numbers of cancers definitively diagnosed among active component military members during the surveillance period. On the other hand, while ACTUR (the DoD tumor registry) and SEER (a U.S. population based cancer registry managed by the National Cancer Institute) are considered gold standards for cancer case identification in the United States, cases that are registered likely underestimate the total of all cancers that affect the populations of interest. Interpretations of the findings of various population-based cancer studies should consider the likely completeness and accuracy of case ascertainment.

In this regard, the Defense Medical Surveillance System (DMSS) contains records of nearly all medical encounters of active component military members in "fixed" (i.e., not deployable or at sea) military and non-military medical treatment facilities. The use of administrative medical records to conduct and enhance cancer surveillance has been extensively studied. In general, the ability of administrative medical records to identify incident cases of cancers has been good, depending on the types of cancers examined and definitions used for case ascertainment. For example, estimates of incidence rates of lung, breast, and colon cancers using administrative data were found to be within six percent of the respective incidence rates that were estimated using SEER data.[8-11]

An important determinant of the quality of health surveillance in general is the completeness and accuracy of case finding. In turn, the criteria used to detect and categorize cases for surveillance purposes (e.g., as possible, likely, or confirmed cases) significantly impact counts of cases of specific conditions and surveillance findings and their implications in general. To inform our selection of cancer case definitions, we reviewed several case finding algorithms before deciding on the case definitions used for this report.

Active military populations differ from the U.S. civilian population in many ways. Several factors that differ in the populations affect both the incidence of and mortality from cancers. For example, the incidence rates of many cancers increase with age, and many behavioral factors are associated with cancer risk including tobacco use, food and alcohol consumption, physical activity, medication use, history of infectious disease and sun exposure,

FIGURE 3a. Cancer-related deaths by year and affected anatomic site/cell type, active component, U.S. Armed Forces, 2000-2011

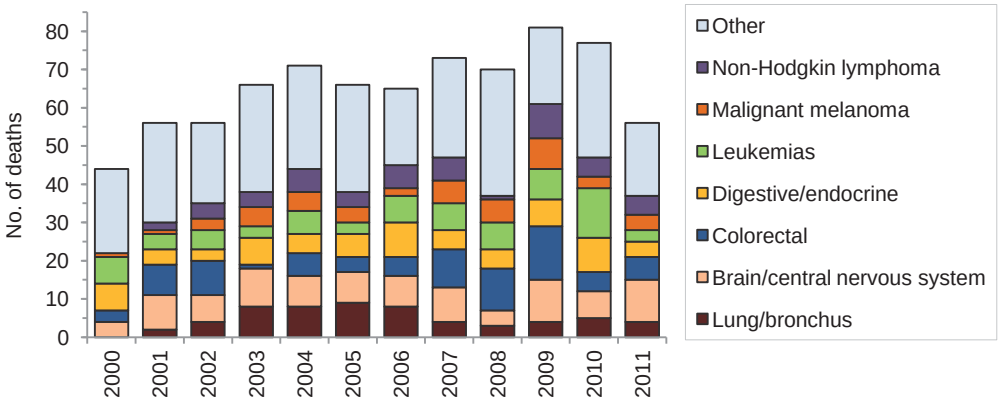
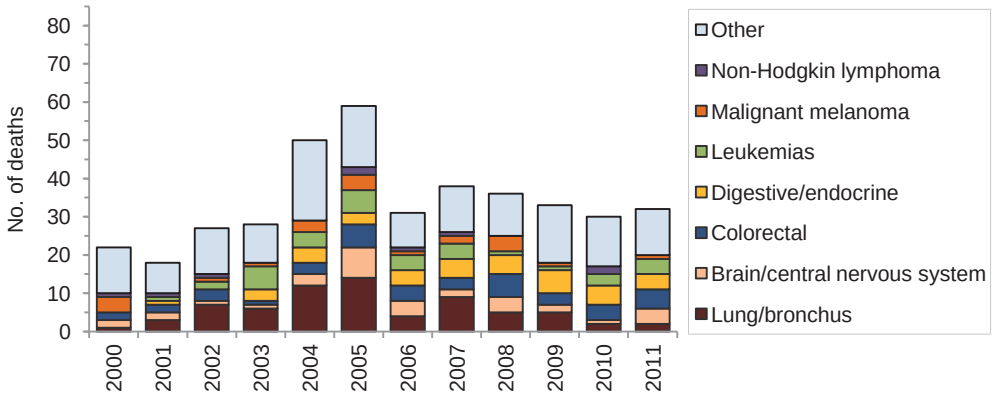


FIGURE 3b. Cancer-related deaths by year and affected anatomic site/cell type, reserve component, U.S. Armed Forces, 2000-2011



and so on. In general, U.S. service members are younger and healthier than their civilian counterparts. All applicants for military service are medically examined before induction, and those with specified medical conditions (e.g., prevalent cancers, HIV-1 infections) are disqualified. In addition, all military services have height, weight, and physical fitness standards; as a result, obesity and sedentary lifestyles (which are correlates of risk for some cancers) are not common among active military members. Military members have unlimited access to health care at no cost to themselves; in addition, they are required to undergo special and periodic medical examinations that may include cancer screening examinations such as mammography, prostate specific antigen (PSA) testing, cytological examination of the cervix (Papanicolaou smear), and so on.

Because military members may seek care for signs or symptoms of cancers at early clinical stages and are subject to relatively intensive medical screening, cancers may be detected earlier in their clinical courses in active military than in civilian populations. If so, rates of cancer diagnoses may be higher among active military members than similarly aged civilians (because they are detected earlier); however, the detection and treatment of cancers at earlier stages may decrease cancer-related mortality among military members compared to civilians.

Interpretations of temporal trends of rates of cancer diagnoses should consider not only changes in screening practices but also changes in behavioral risk factors in relation to the clinical latencies of cancers of interest. For example, cigarette smoking is a significant risk factor for several cancers. While the U.S. military discourages cigarette smoking by its members and prohibits smoking in some settings, smoking prevalence remains higher among active military members (31%) than in the general U.S. population (20%).[12-13] This report documented a low incidence of lung cancers among military members; however, the finding may reflect the long latency of smoking-related lung cancer; lung cancer cases related to current tobacco smoking may not be clinically apparent until after affected members leave active service. Unquestionably, smoking cessation should be a high priority for all military health care and public health practitioners.

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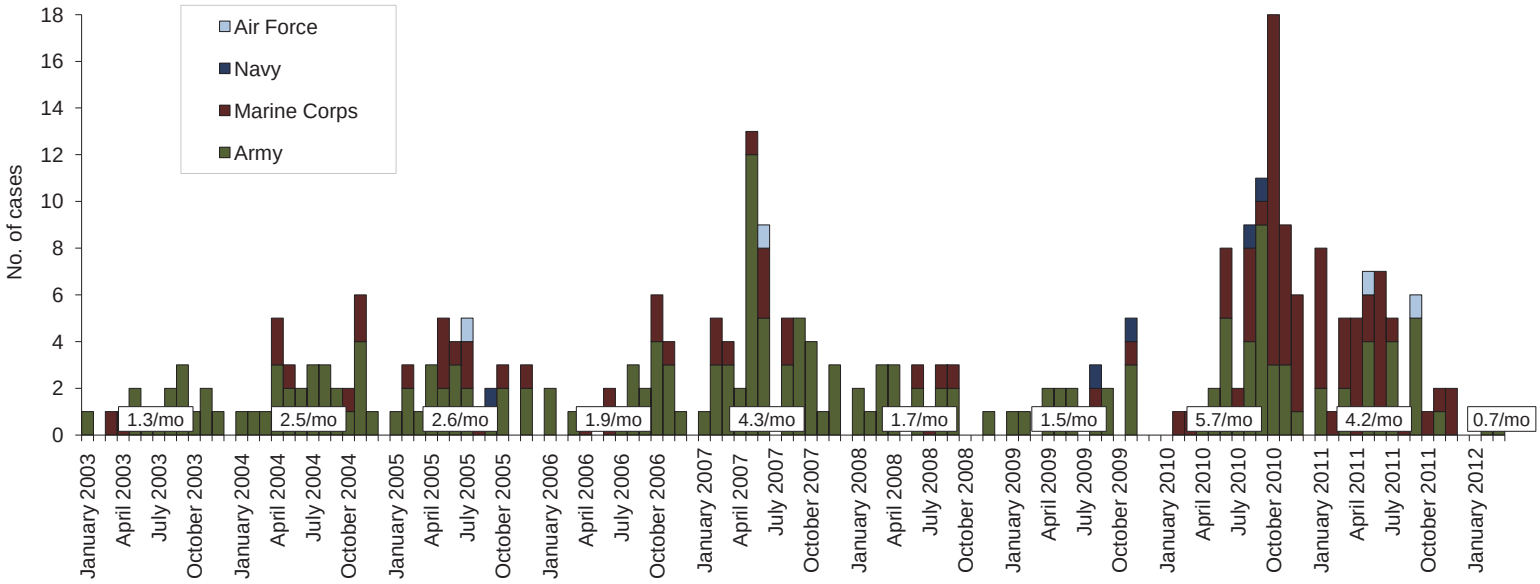
Surveillance Snapshot: Deployment-related Injuries to External Genital Organs by Month and Service, Active and Reserve Components, U.S. Armed Forces, January 2003- April 2012

Open wounds of genital organs (external) (ICD-9-CM: 878.x)



Note: One hospitalization per individual or one outpatient encounter that occurred during a hospitalization while deployed to/within 365 days of returning from OEF/OIF/OND.