

## Cancer Incidence in Australian Vietnam Veterans

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### Introduction

Australian Defence Force (ADF) personnel participated in the Vietnam Conflict from 1962 to 1973, involving nearly 60,000 personnel, of whom over 500 died during service and 3131 were severely physically wounded. Service in the Vietnam conflict presented distinct health challenges. Besides the hazards of combat conditions for extended periods, herbicides and other toxic chemicals were used extensively. The United States military sprayed more than 76,000,000L of herbicide over Vietnam in their Air Force Ranch Hand and Operation Trail Dust programs.<sup>1</sup> The most heavily used herbicide was Agent Orange, contaminated with 2,3,7,8-tetrachlorodibenzo-*p*-dioxin.

Since the Vietnam conflict, ex-Service organisations (ESOs) have maintained that Vietnam service adversely affected the health of veterans. Initial studies showed no excess risk attributable to their service.<sup>2-4</sup> However, more recent studies have shown that Vietnam veterans have excess incidence and mortality rates from several conditions such as cancers and heart disease.<sup>5-9</sup>

This paper describes the first cancer incidence study for all ADF Vietnam veterans.

### Methods and Materials

The nominal roll of male Australian Defence Force (ADF) Vietnam veterans was compiled for a previous study.<sup>9</sup> Following public consultation since the previous study, amendments and additions were made to the roll after confirmation with service records. The names and date of birth of the veterans were matched with a number of national databases to determine vital status and cancer incidence. The sources of data were: the National Death Index (NDI), Australian Electoral roll, the Health Insurance Commission, the Department of Veterans' Affairs Client database, State and Territory Births, Deaths and Marriages for pre 1980 death records, and the National Cancer Statistics Clearing House (NCSCCH). The NDI contains all deaths in Australia from 1980 to the present. Cancer is a notifiable disease in Australia and each state registry submits information on all diagnosed cancers, except non-melanocytic skin cancer, to the NCSCCH. Integrity probabilistic matching software was used to match to the NDI, the Australian Electoral roll and the NCSCCH. Matching to all other databases required essentially an exact match on name

and date of birth. Matching to the NCSCCH identified all notifiable cases of cancer between 1982 and 2000.

Standardised incidence rates were calculated using the person-year method. The expected number of cases of cancer by cancer type was calculated by applying age-specific cancer incidence rates for the Australian male community to the number of living Vietnam veterans in that age group in each year.

## Results and Discussion

The cohort of Australian ADF Vietnam veterans (N=59,187) consisted of 41,087 Army veterans, 13,538 Navy veterans and 4,570 Air Force veterans who served in Vietnam between 23 May 1962 and 1 July 1973. Seven servicemen served in both the Army and Navy and one serviceman served in the Air Force and Army. Vital status was determined for 96.2% of the cohort. Matching to the NCSCCH database compiled from the cancer registries in all states and territories of Australia resulted in 4623 cancers identified from 1982 through 2000.

Table 1 shows the results for all military Australian Vietnam veterans. Their incidence rate for all cancers was 18% higher than the Australian male community. The incidence rate of cancers of colorectum, prostate, head and neck, oropharynx and larynx, and lung were significantly elevated. Incidence rate for Hodgkin's disease was more than double the Australian rate and incidence of melanoma and chronic lymphocytic leukemia was also elevated. Incidence rate of cancer of the liver, non-Hodgkin's lymphoma and multiple myeloma was statistically lower than community norms.

The incidence of cancer varied by service branch (Table 2). Navy veterans had the highest incidence rate of cancer of the three service branches, elevated by 28%. In contrast to the whole ADF cohort, the incidence of Hodgkin's disease was not significantly elevated and non-Hodgkin's lymphoma was not significantly lower among Navy veterans.

Army veterans exhibited a 15% elevated cancer incidence rate. The pattern of cancer incidence differed from the total cohort in that colorectal cancer was not significantly elevated and liver cancer and multiple myeloma incidence rate, although lower did not reach statistical significance. The incidence of mesothelioma among Army veterans was significantly lower than community norms.

Air Force veterans exhibited a 10% increase in overall cancer incidence with only melanoma and prostate cancer statistically significantly elevated. Incidence rates of liver cancer, non-Hodgkin's lymphoma and mesothelioma were significantly lower than the Australian community norms.

**Table 1:** Standardised incidence ratios (SIR) for Australian Vietnam veterans

Cancer	No. of Cancers	SIR	95% CI
All Cancers	4623	1.18	1.14-1.21
Connective soft tissue	35	1.00	0.67-1.33
Colorectal	628	1.10	1.01-1.18
Prostate	699	1.28	1.18-1.37
Head and Neck	247	1.50	1.31-1.68
Oropharynx and larynx	344	1.49	1.33-1.65
Liver	27	0.71	0.44-0.98
Lung	581	1.26	1.15-1.36
Hodgkin's disease	51	2.08	1.51-2.65
Non-Hodgkin's lymphoma	126	0.68	0.56-0.79
Melanoma	762	1.35	1.25-1.44
Multiple myeloma	32	0.69	0.45-0.93
Mesothelioma	27	0.81	0.51-1.12
Leukaemia	131	1.20	1.00-1.41
Chronic Lymphocytic	58	1.56	1.16-1.97

The pattern of neoplasms among Australian Vietnam veterans is somewhat unexpected given the known exposure to Agent Orange and the results of other studies. Although veterans of this conflict were exposed to dioxin contaminated herbicides, there are no accurate measures of the level of that exposure. The Australian Army contingent in Vietnam served primarily in Phuoc Tuy Province, an area incurring heavy herbicide spraying.<sup>10</sup> A study of the mechanisms for production of potable water on ships serving during the Vietnam conflict has confirmed the potential for Navy personnel to have been exposed to hazardous levels of dioxin while in Vietnamese waters.<sup>11</sup> Of the three service branches, Australian Air Force personnel would have had a lower potential for exposure to herbicides.

A previous study of morbidity of Australian Vietnam veterans showed a higher than expected incidence of non-Hodgkin's lymphoma and chronic lymphocytic leukemia.<sup>6</sup> The *Veterans and Agent Orange* update 2002<sup>12</sup> found sufficient evidence of an association between herbicide exposure and chronic lymphocytic leukemia, soft tissue sarcoma, non-Hodgkin's lymphoma and Hodgkin's disease. Furthermore the study found limited or suggestive evidence of an association between herbicide exposure and respiratory cancer, prostate cancer and multiple myeloma.

The elevated incidence of some of these neoplasms, such as prostate cancer, lung cancer, and Hodgkin's disease, in the Australian Vietnam veteran population concur with some of the associations described with herbicide exposure. Interestingly, non-Hodgkin's lymphoma and multiple myeloma incidences are statistically lower than expected. In this study the identification of cancers was from 1982 through 2000. Thus cancers occurring in the first 10 to 20 years following Vietnam service have not been identified. As haematopoietic neoplasms occur within a relatively short time after exposure, some of these cancers may have been missed within the veteran cohort. Betazzi et al<sup>13</sup> found in the Seveso study that Hodgkin's disease risk was elevated

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in the first 10 years following exposure to dioxin whereas increased risk for non-Hodgkin's lymphoma and multiple myeloma occurred after 10 years. The cancer incidence pattern seen in this Vietnam veteran cohort does not suggest a similar pattern.

The incidence rate for soft tissue sarcoma does not differ from the community norm for this cohort. Although environmental and occupational studies show evidence of an association with herbicide exposure and soft tissue sarcoma, studies of Vietnam veterans are less clear.<sup>12</sup>

This study has shown that Australian Vietnam veterans demonstrate an elevated incidence of cancer. The pattern of statistically elevated or lower cancer incidence rates varies between the service branches.

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**Table 2:** Standardised Incidence Ratios (SIRs) for Australian Vietnam veterans by branch of service

Cancer	Navy			Army			Air Force		
	No. of cancers	SIR	95% CI	No. of cancers	SIR	95% CI	No. of cancers	SIR	95% CI
All Cancers	1080	1.28	1.21-1.36	3036	1.15	1.11-1.20	507	1.10	1.01-1.20
Connective soft tissue	6	0.78	0.16-1.41	29	1.21	0.77-1.65	0	0.00	0.00-0.00
Colorectal	148	1.21	1.01-1.40	402	1.06	0.95-1.16	78	1.11	0.87-1.36
Prostate	139	1.22	1.02-1.42	456	1.29	1.17-1.41	104	1.29	1.04-1.54
Head and Neck	56	1.57	1.16-1.98	174	1.56	1.33-1.79	17	0.94	0.49-1.39
Oropharynx and larynx	77	1.55	1.21-1.90	243	1.57	1.37-1.77	24	0.91	0.55-1.28
Liver	8	0.97	0.30-1.64	18	0.72	0.39-1.05	1	0.22	0.00-0.65
Lung	143	1.47	1.23-1.71	375	1.24	1.11-1.36	63	1.00	0.75-1.25
Hodgkin's disease	7	1.27	0.33-2.21	40	2.33	1.61-3.06	4	2.08	0.04-4.12
Non-Hodgkin's lymphoma	31	0.77	0.50-1.04	86	0.68	0.53-0.82	9	0.48	0.17-0.80
Melanoma	175	1.41	1.20-1.61	514	1.32	1.21-1.43	73	1.41	1.09-1.74
Multiple myeloma	4	0.41	0.01-0.81	22	0.71	0.41-1.01	6	1.10	0.22-1.99
Mesothelioma	12	1.72	0.75-2.69	14	0.63	0.30-0.96	1	0.25	0.00-0.73
Leukaemia	35	1.49	1.00-1.99	81	1.10	0.86-1.34	15	1.25	0.62-1.88
CLL*	12	1.53	0.66-2.39	42	1.70	1.19-2.22	4	0.88	0.02-1.74

\*Chronic lymphocytic leukemia

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