Mortality in Australian Vietnam veterans, 1982-1994

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Introduction
Vietnam veterans are a group with potential exposure to phenoxy herbicides and 2,3,7,8-TCDD. They also have exposure to combat stress and various infective agents that may have adverse effects on their long-term health.

Australia has slightly more than fifty nine thousand Vietnam army, navy and airforce veterans, who served in Vietnam from 1962 until 1973. The majority of these served in an area that was particularly heavily sprayed with defoliants during the Vietnam war.

Recent reviews of the literature by the National Academy of Sciences have suggested that there are a range of adverse health effects associated with exposure to herbicides in Vietnam, such as soft tissue sarcoma and non-Hodgkin's lymphoma. [1,2] In addition, these reviews have suggested that there a range of health effects that are possibly associated with exposure to herbicides, such as lung and prostate cancer.

Material and Methods
A list of all Australian Vietnam veterans was developed from primary records of the Defence Forces; in Australia, such a list is called a Nominal Roll.

This Nominal Roll was matched against the National Death Index (NDI), and the database of deaths of the Department of Veterans' Affairs Client Database (DVA CDB). It was also matched against the electoral rolls, and the Medicare database, both of which contain the names of nearly all living Australians within Australia.

It was discovered that matching against both the NDI and the DVA CDB resulted in substantial under-ascertainment of death. That is, there were veterans found to be dead on the NDI, who could not be located on the DVA CDB, and veterans known to be dead on the DVA CDB who could not be matched on the NDI. Logically, there would be some veterans who had died, and were not being matched on either database. This under-ascertainment was substantial, and was different for various different International Code of Disease (ICD) Chapters.

Calculation of Standardised Mortality Ratios (SMR) was adjusted to correct for this under-ascertainment. This correction was made by deflating the number of expected deaths for each cause of death and ICD chapter.

There was a concern that this correction resulted in a bias, so Standardised Relative Mortality Ratios (SRMR) were also calculated. These are the ratio of two SMRs, and, as any bias would be contained in both the numerator and the denominator, the bias would be, in effect, cancelled out. Although this is an effective method of removing bias for under-ascertainment, it is a form of proportionate analysis, and has the limitations common to this type of analysis.

Further, there was reason to believe that malignant diseases, which were of particular interest in this study, were more commonly ascertained than were deaths from other causes. For this reason, for individual malignancies, SRMRs were calculated using both "all other deaths" and "other malignant deaths" as the denominator.

Results and Discussion

The results of the adjusted SMRs are found in Table 1. There is evidence of excess mortality among Vietnam veterans, when compared to the rest of the Australia population, with a seven per cent increase in mortality. However, the overall level of excess is difficult to estimate accurately because of a continuation of the healthy worker effect for some causes, and bias in the estimation method due to the under-ascertainment of deaths.

Table 1 – Adjusted SMRs for Selected Causes of Death

Cause of death	SMR	95% CI
All causes	1.07	(1.02, 1.12)
Neoplasms (cancer)	1.21	(1.11, 1.31)
Prostate cancer	1.53	(1.07, 2.12)
Lung cancer	1.29	(1.12, 1.49)
Ischaemic heart disease	1.10	(1.01, 1.21)
Suicide	1.21	(1.02, 1.42)

While the SMR for suicide was statistically significantly elevated (albeit only just), the SRMR was not significantly elevated, with an SRMR of 114 (97,133). Taken together, these results do not preclude excess in risk of death from suicide.

As was expected, there were a number of ICD chapters for which there was significant deficits of deaths. This occurs because of the healthy worker effect, in which a population screened for fitness to work show deficits from certain causes of death. Table 2 shows the results of those ICD chapters that were significantly decreased.

Table 2 – Adjusted SMRs for Selected Causes of Death

Cause of death	SMR	95% CI
Endocrine, nutritional and metabolic diseases	0.71	(0.53, 0.93)
Mental disorders	0.50	(0.27, 0.85)
Congenital anomalies	0.15	(0.00, 0.81)

There was evidence that death from malignant disease plays a role in the excess mortality, with an SMR for that ICD Chapter showing a significant 21 per cent elevation. The adjusted SMRs for selected cancers of *a priori* interest are shown in Table 3. Overall, there were 803 deaths

from malignant disease in Australian Vietnam veterans in the period under consideration. For certain types of cancer, particularly lung cancer, and to a lessor extent, prostate cancer and non-Hodgkin's lymphoma, there were large numbers of observed and expected deaths, but for other tumours, such as sarcoma, Hodgkin's disease and multiple myeloma, the number of deaths observed and expected were small. Thus, the study has limited ability to make meaningful observations about the underlying incidence of these less common tumours.

Table 3 – Adjusted SMRs for Selected Sites of *a priori* Interest

Site	Deaths			SMR	95% CI
	Observed	Expected[1]	Expected[2]		
Site of a prior interest					
All neoplasms	803	831.7	664.1	1.21	(1.11, 1.31)
Non Hodgkin's lymphoma	33	39.8	31.9	1.04	(0.71, 1.46)
Soft tissue and other sarcomas	9	11.3	9.0	1.00	(0.46, 1.91)
Hodgkin's disease	5	6.0	4.7	1.06	(0.34, 2.46)
Prostate	36	29.2	23.6	1.53	(1.07, 2.12)
Multiple myeloma	6	11.8	9.5	0.63	(0.23, 1.38)
Lung	212	205.6	164.1	1.29	(1.12, 1.49)

(1) Expected deaths using Australian male 5-year age groups and single calendar years.
(2) Adjusted for under-ascertainment.

While the SMR suggested that the population suffered from an increase risk of death from lung and prostate cancer, the proportionate analysis provided some evidence that this could be an artefact of the methods of adjusting for under-ascertainment. Thus, the study concluded that there is evidence that lung cancer and prostate cancer plays a role in the increased mortality of Australian Vietnam veterans.

Some other studies of Vietnam veterans have found an elevation in lung cancer mortality. For example, a proportionate study by Wanatabe and colleagues found a slight but significant elevation in lung cancer mortality.[3] An earlier study of New York veterans had also noted a significant elevation in lung cancer mortality,[4] but other studies in Australia[5] and America[6] have not detected this increase, and an Australian cancer incidence study has not found evidence of elevation in lung cancer in all veterans.[7]

No other study of Vietnam veterans has reported a significant elevation in prostate cancer mortality.

Table 4 – SRMRs for Specific Cancer Sites

Protocol specified cancer site	SRMRs			
	SRMR[a]	(95% CI)	SRMR[b]	(95% CI)
Non-Hodgkin's lymphoma	85	(60, 121)	97	(68,137)
Soft tissue, other sarcomas	83	(42, 162)	94	(43, 178)
Hodgkin's disease	87	(36, 214)	99	(32, 230)
Prostate	128	(91, 179)	143	(102, 200)
Leukaemia	105	(73, 149)	118	(83, 168)
Multiple myeloma	52	(23, 118)	59	(22, 129)
Lung	109	(93, 128)	123	(106, 142)

(a) The SRMR is the ratio between the SMR for the specific site and the SMR for all other cancer sites combined.
(b) The SRMR is the ratio between the SMR for the specific site and the SMR for all other causes of death combined.

This study has a number of strengths. It was reasonably large, and identification of the veteran population was close to complete. The population was followed until the end of 1994, so that the length of time since exposure to Vietnam ranged from 22 to 32 years. Vital status was established for 96.9 per cent of the cohort.

The study had several weaknesses. The most obvious was that there was under-ascertainment of death when linking to the various databases. Although methods were used to adjust for this and estimate SMRs, bias could not be completely eliminated. The study also suffered from lack of measurement of exposures in Vietnam.

The study will be repeated in the year 2001, when the mortality experience from 1995 to the year 2000 will be studied.

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