Australian Government
Department of Veterans' Affairs
Australian Institute of Health and Welfare

The Third Australian Vietnam Veterans Mortality Study

2005

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Australian Government
The Repatriation Commission

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The Hon Bruce Billson, MP
Minister for Veterans' Affairs
Parliament House
CANBERRA ACT 2600

Dear Minister

I have pleasure in submitting to you the final report of the *The Third Vietnam Veterans Mortality Study 2005*. This study has investigated the mortality for male military Vietnam veterans from the end of their service to 31 December 2001. This study extends the previous mortality study of Vietnam veterans which was published in 1997.

This report is the second of four volumes to be published in this series on Vietnam veterans. The first volume was a cancer incidence study of Vietnam veterans. The third volume will investigate the mortality and cancer incidence of National Servicemen and the fourth volume will extend the 1992 Dapsone study.

I would like to take this opportunity to acknowledge the contribution of my predecessor, Major General JP Stevens AO, who guided the commencement of this study.

I would like to acknowledge the important role played by the members of the Vietnam Veterans Study Consultative Forum who provided invaluable assistance during the conduct of the study. A full list of the members representing key ex-Service organisations on the forum is listed in Appendix F of the Mortality report.

The report's preparation was supervised by an independent Scientific Advisory Committee, who undertook to ensure the scientific rigour of the study. The membership of the Committee is listed in Appendix G of the report.

I would also like to acknowledge the Australian Institute of Health and Welfare, and Dr Keith Horsley, Senior Medical Advisor, Dr Eileen Wilson, Epidemiologist and other departmental staff who worked on the study.

Yours sincerely

Simon Harrington
COMMISSIONER

13 February 2006

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THE UNIVERSITY OF
NEW SOUTH WALES

31 October 2005

Rear Admiral Simon Harrington AM
Repatriation Commissioner
Department of Veterans' Affairs
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PROFESSOR
PETER SMITH
DEAN
Faculty of Medicine

Dear Admiral Harrington

On behalf of my fellow members of the Scientific Advisory Committee, I would be grateful if you could convey to the Minister for Veterans' Affairs the committee's view that the second volume of the current series of studies – *The third Australian Vietnam Veterans Mortality Study 2005* – has been completed satisfactorily. The Committee is of the opinion that the study has been done with appropriate diligence and rigour, and that the methodology used is appropriate to the task at hand.

As the report notes, the study has found that veterans displayed lower rates of mortality than the Australian community at least partly due to the healthy worker effect. However the manifestation of the healthy worker diminishes over time and the mortality for some causes of death in the last decade of observation is higher than expected. There were also some individual cancers for which the mortality rate was higher than expected.

Further work is well advanced and the Committee continues to carefully monitor the progress of this work.

It is often appropriate for the Chair of the Scientific Advisory Committee, on behalf of and with the concurrence of fellow members of the Committee, to offer recommendations for the future in letters of transmission to the Government. However, in this case, as the other reports will be ready later this year, the Committee feels that it would be more appropriate to wait until all four volumes of work have been completed and to make recommendations for the future in the final letter.

If we can be of any additional assistance to the Minister or to the Commission, the Committee would be happy to provide such assistance.

Yours sincerely,

Professor Peter Smith RFD
Chair
Scientific Advisory Committee
3rd Vietnam Veterans Mortality and Cancer Incidence Study

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Abbreviations

AATTV	Australian Army Training Team Vietnam
AEC	Australian Electoral Commission
AIHW	Australian Institute of Health and Welfare
ARVN	Army of the Republic of Vietnam
AVHS	Australian Veteran Health Study
CARO	Central Army Records Office
CMF	Civilian Military Force
CNS	Central Nervous System
COD	Cause of Death
COPD	Chronic obstructive pulmonary disease
DIMIA	Department of Immigration, Migration and Indigenous Affairs
DOD	Department of Defence
DVA	Australian Government Department of Veterans' Affairs
HWE	Healthy worker effect
HIC	Health Insurance Commission
ICD	International Classification of Disease
MVA	Motor Vehicle Accidents
NAA	National Archives of Australia
NAS	National Academy of Science
NCSCH	National Cancer Statistics Clearing House
NDI	National Death Index
NHL	Non-Hodgkin's Lymphoma
NRCET	National Research Centre for Environmental Toxicology
NRVV	Nominal Roll of Vietnam Veterans
NYSIIS	New York State Intelligence Information System
PTSD	Post-traumatic stress disorder
RAAF	Royal Australian Air Force
RAN	Royal Australian Navy
RAR	Royal Australian Regiment
RBDM	Registrars of Birth Deaths and Marriage
RN	Royal Navy (British)
RNZN	Royal New Zealand Navy
RR	Relative Ratio
SEATO	South-East Asian Treaty Organisation
SD	Standard deviation
SIR	Standardised Incidence Rate
SMR	Standardised Mortality Rate
USAF	United States Air Force
USN	United States Navy
VEA	*Veterans' Entitlements Act 1986*
VVMS	Vietnam Veterans Mortality Study, published in 1997

Definitions

Australian Vietnam veteran study cohort: All male Australian members of the defence forces and the Citizen Military Forces (CMF) who were allotted or deemed allotted for service in Vietnam; all Australian members of the defence forces who landed in Vietnam including those who were seconded to the Army of the Republic of Vietnam (ARVN), the United States Air Force (USAF), the United States Navy (USN) and any other allied service; all members of the Australian Army Training Teams Vietnam (AATTV); who saw service in Vietnam during the period between 23 May 1962 and 1 July 1973.

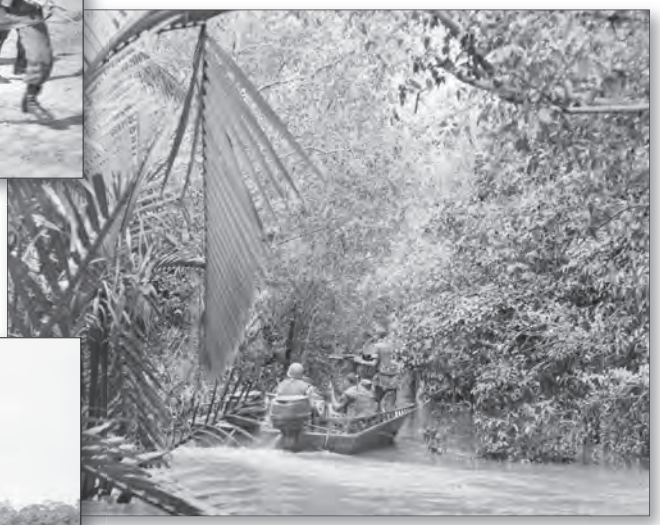
Allotted for Duty means a person or unit of the Defence Force that was allotted for duty in an operational area. Allotment may be retrospective or prospective, and occurs via a written instrument issued by the Defence Force;

Operational Service is rendered where a person is allotted for duty and serves in an operational area. Current use of this term is not the same as normal posting procedures used in the Defence Force to move members from one unit to another.

Army troops disembarking HMAS *Sydney* at Vung Tau *[AWM THU/68/0335B/VN]*

RAN Helicopter Flight Vietnam Iroquios helicopters picking up troops. *[Courtesy of the Sea Power Centre – Australia]*

Soldiers moving out from an M113 armoured personnel carrier northeast of Saigon *[AWM KEL/65/0016/VN]*



Members of the RAN clearance diving team on patrol in the Mekong Delta *[AWM P03654.013]*

Mortar fire near Bien Hoa air base *[AWM DNE/65/0179/VN]*

Soldiers crossing a stream southwest of Saigon during a search and destroy mission *[AWM SHA/66/0006/VN]*

HMAS *Hobart* closed up for action, Vietnam *[AWM NAVYM0167/05]*

Flight deck of HMAS *Sydney* at Vung Tau *[AWM DNE/65/0111/VN]*

A RAAF transport flight Caribou aircraft undergoing repairs in Ha Tien *[AWM P01059.001]*

Armoured personnel carrier in dense jungle, Phuoc Tuy province *[AWM P01777.003]*

Executive Summary

Study initiation

A key recommendation of the 1997 *Mortality of Vietnam Veterans: The Veteran Cohort Study* was to monitor the mortality of Vietnam veterans and repeat the study after 2000. In 2002, the then Minister for Veterans' Affairs agreed that the Repatriation Commission should undertake the *Third Vietnam Veterans Mortality Study* and *Cancer Incidence in Vietnam Veterans Study*. The Commission asked the Australian Government Department of Veterans' Affairs (DVA) to conduct these studies which were undertaken with assistance from the Australian Institute of Health and Welfare (AIHW).

This report is the second of four volumes published in this third series of studies on Vietnam veterans. The other volumes are:

- *Cancer Incidence in Australian Vietnam Veterans Study 2005;*
- *Australian National Service Vietnam Veterans: Mortality and Cancer Incidence 2005;* and
- *Dapsone exposure and Australian Vietnam Service: Mortality and Cancer Incidence 2005*.

Study objectives

The objectives of the mortality study were to:

- identify all deaths among the male Australian Vietnam veteran cohort from the time of completing Vietnam service to 31 December 2001;
- compare the number of deaths among Vietnam veterans with the number of expected deaths based on mortality of the Australian community;
- report any differences in the mortality for specific causes of death, as highlighted by past studies and the literature review, from the Australian community; and
- investigate any differences in mortality between Navy, Army and Air Force Vietnam veterans from the Australian community.

Study design

The mortality study was a retrospective cohort study of male Australian personnel who served in Vietnam between 23 May 1962 and 1 July 1973. The study examined all deaths identified during the period from completion of Vietnam service to 31 December 2001. The study compares the mortality rates of male Australian Vietnam veterans with those of Australian males in the general community. All comparisons have been standardised by age and calendar year of death. In addition, the study analysed whether mortality rates vary between different groups of Vietnam veterans.

Report structure

Chapter One of this Report provides a background to previous studies and an overview of the study. **Chapter Two** provides a brief summary of the Vietnam War and Australia's involvement.

The roll compiled for this study was drawn from the Nominal Roll of Vietnam Veterans (NRVV) currently maintained by DVA, as described in **Chapter Three**. The Nominal Roll has been extensively updated since it was last published in 1997, although it does not yet contain all the information required to be published as a commemorative nominal roll. The Study Roll is a list of all those male defence personnel currently identified as serving in Vietnam between May 1962 and July 1973. The Study Roll contains a total of 59,179 male military Vietnam veterans.

The methods used for this study are outlined in **Chapter Four**. In brief, the Study Roll was matched against a number of databases, allowing determination of vital status (that is, whether a person is alive or dead), and determining the number of deaths and cause. Vital status was determined for 97.3% of the cohort and 2.7% were lost to follow up. The number of deaths observed amongst the Vietnam veterans was compared to the number expected in Australian men of the same age.

As outlined in **Chapter Five**, the nature of service varied considerably between the Service branches. Army and Air Force veterans averaged approximately one year of service in Vietnam whereas Navy veterans averaged approximately three months. Navy personnel were substantially younger than Army or Air Force personnel were when they first served in Vietnam.

The results of the mortality analysis are presented in **Chapter Six** and these findings are discussed in **Chapter Seven**.

Features of the study

This study has a number of features inherent to a retrospective epidemiological study of a military cohort and other features that are unique to this study.

Among the strengths is the relatively small proportion of veterans whose vital status could not be ascertained. Further, this number was much smaller than the number of veterans who had died. Thus the distorting effect of those with unknown vital status as a proportion of those known to be alive or dead would be minimal. In addition, this was a large study, with nearly 60,000 men followed for up to 35 years, providing almost 1.9 million person-years of follow up. The study population was racially homogenous, and all were male. This provides ease of comparison.

The study has a number of limitations. There are many diseases, causes of disability and aspects of health that, as with any mortality study, are not measured by this study. The study has little information about exposures on service in Vietnam. Although this cohort was exposed to a range of stresses and toxicants, little is known about the amount of exposure that either individual veterans or groups of veterans experienced. In effect, it describes an overall average exposure of the Vietnam experience. In addition any adverse or beneficial health exposures an individual may have experienced following Vietnam service are also not known or quantified. Moreover, this study investigates over 60 specific causes of cancer or non-cancer mortality. Thus the concept of statistical significance for multiple comparisons needs to be considered. By the conventional definitions used, a statistically significant result has up to a one in twenty probability to be due to chance.

Another feature of this study was the existence of a “healthy worker effect”. The cohort at the point of selection for service in Vietnam was much healthier than the general population. This phenomenon has long lasting effects which generally results in lower overall mortality rates for the cohort under study when compared to the general population and may result in a decrease in mortality even if there were specific factors in Vietnam that would increase mortality. The next study in this series, *Australian National Service Vietnam Veterans: Mortality and Cancer Incidence 2005*, controls for the healthy worker effect by comparing National Servicemen who did and did not serve in Vietnam.

Findings

- The results presented in **Chapter Six** show that overall Australian Vietnam veterans had a 6% lower than expected mortality compared to the Australian male population. This reduction was, however, restricted to the two decades immediately after the Vietnam War and was no longer seen in the most recent decade of observation, when the all-cause mortality for Vietnam veterans did not differ from community norms.
- For many causes of death, Australian Vietnam veterans had a lower than expected mortality overall, including lower than expected mortality from circulatory diseases (12%), respiratory diseases (23%) and infectious diseases (38%). In the most recent decade of observation, however, mortality from respiratory diseases was no longer lower than expectation and was higher than expected for diseases of the liver (27%), particularly alcoholic liver disease (48%).
- Mortality overall from all neoplasms was 6% higher than expected and mortality from lung cancer and cancers of the head and neck region was significantly higher than expected; 18% and 34–44% respectively. Moreover, in the most recent decade of observation mortality from prostate cancer was higher than expected (29%).
- In contrast to a previous validation study, mortality from non-Hodgkin's lymphoma was 22% significantly lower than expected.
- Mortality amongst Navy veterans was not significantly different from the Australian population but their mortality from cancer was 19% higher than expected.
- Specifically, Navy veterans had a higher than expected mortality from lung cancer (39%) and melanoma (56%), whereas mortality from non-Hodgkin's lymphoma was 48% lower than expected. Also mortality from mesothelioma was higher than expected based on small numbers.
- Overall mortality amongst Army veterans was 7% significantly lower than expected and no single non-cancer cause of death analysed was significantly elevated.
- Those causes of death amongst Army veterans that were significantly lower than expected include infectious diseases (46%), nervous system diseases (24%), circulatory system diseases (14%) and respiratory system diseases (20%).
- Although mortality from all neoplasms amongst Army veterans was not different from the Australian community, mortality from cancers of the head and neck region was 39% – 49% higher than expected. Mortality from lung cancer was 13% higher than expected and mortality from cancer of the pancreas was 30% higher than expected but these were of borderline statistical significance. Also, mortality from eye cancer was higher than expected based on five deaths.

- Air Force veterans had a 9% lower than expected overall mortality. Mortality from circulatory system diseases was 13% lower than expected and 36% lower than expected from respiratory diseases.
- Mortality from all neoplasms amongst Air Force veterans was not different from the Australian community and mortality from stomach cancer was 59% lower than expected.

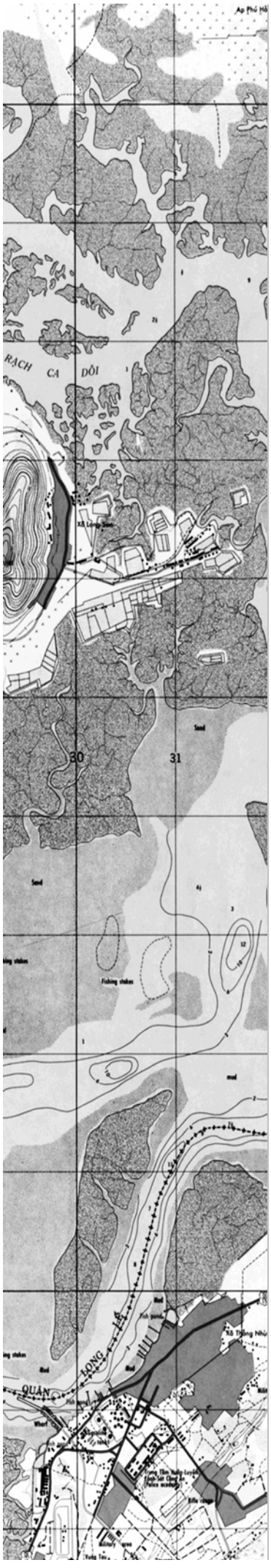
Summary and Conclusion

Overall, Australia's veterans of the Vietnam War displayed lower rates of mortality than the Australian community. The healthy worker effect, the selection of men who were fit at the time of service, at least in part, accounts for this overall lower mortality. However the manifestation of the healthy worker effect diminishes over time and the mortality for some causes of death in the last decade of observation is higher than expected. There were also some individual cancers for which the mortality rate was higher than expected.

Taken together with the Cancer Incidence Study, there were several cancers for which both the incidence and mortality were higher than expected. These include lung cancer, cancers of the oral cavity and head and neck and in recent times prostate cancer. There were also several cancers for which incidence was higher than expected but mortality was not different from expectation. These include colon cancer, cancers of the genitourinary system, melanoma and Hodgkin's disease. Furthermore there was one cancer, non-Hodgkin's lymphoma, for which both mortality and incidence were possibly lower than expected.

This study provides contradictory results for causes of death of *a priori* interest and/or associated with herbicide exposure. Many did not differ from expectation, some were possibly significantly lower than expectation (non-Hodgkin's lymphoma) and others displayed rates that were higher than expected (lung cancer and head and neck cancer and in more recent times prostate cancer).

In conclusion, this group of Vietnam veterans was followed for 30 years. Over that 30 years their mortality was 6% lower than expected. However, for the last period of observation the all-cause mortality rate for this group does not differ from expectation and the mortality for some causes was higher than expected.



1

Introduction

Chapter 1 Introduction

A key recommendation of the 1997 *Mortality of Vietnam Veterans: The Veteran Cohort Study* was to monitor the mortality of Vietnam veterans and repeat the study after 2000. In 2002, the Minister for Veterans' Affairs agreed that the Repatriation Commission should undertake the *Third Vietnam Veterans Mortality Study* and *Cancer Incidence in Vietnam Veterans Study*. The Commission has tasked the Australian Government Department of Veterans' Affairs (DVA) to conduct the studies. These studies were conducted with assistance from the Australian Institute of Health and Welfare (AIHW).

This report is the second of four volumes to be published in this series of studies of Vietnam veterans. The first volume was a cancer incidence study of all Vietnam veterans. The third volume will investigate the mortality and cancer incidence of national service veterans and non-veterans. Finally the fourth volume will repeat the 1992 Dapsone study to investigate the effect of exposure to this anti-malarial drug on mortality and cancer incidence among the Army cohort.

1.1 Previous studies undertaken by the Department

Several key studies on the health of Australian Vietnam veterans funded by the Australian government through DVA have been published since the Vietnam conflict.

1.1.1 Australian Veterans Health Studies

In 1980, the Australian government commissioned the Commonwealth Institute of Health (now known as the Australian Institute of Health and Welfare, AIHW) to conduct a series of studies into the health of Vietnam veterans and their families. A retrospective cohort mortality study of 46,166 Australian national servicemen, the *Australian Veterans Health Studies* (AVHS), was completed in 1984.[1] The study compared the mortality of national service veterans who served in Vietnam to national service personnel who remained in Australia. This study found no significant increase in mortality among veterans compared to non-veterans. Both veterans and non-veterans had significantly lower mortality rates than expected for a similar aged cohort of Australian males.

As part of the AVHS, a pilot study was undertaken into the feasibility of an epidemiological investigation of morbidity in Vietnam veterans.[2] Although a four volume report was published from the pilot study, the planned morbidity study did not eventuate at this time.

1.1.2 Dapsone exposure, Vietnam service and cancer incidence study

Dapsone, an antimalarial drug used by the Army during the Vietnam War, had been shown to be associated with toxicity on white blood cells and other adverse reactions, such as haemolytic anaemia and peripheral neuropathy.[3,4] Concerns were also raised about the possible carcinogenicity of this drug.[5] In 1992, AIHW examined the relationship between dapsone exposure, Vietnam service and cancer incidence among 115,407 Australian Army personnel; comprising 40,274 Vietnam veterans and a comparison group of 75,133 members serving during the Vietnam era.[6] The study compared cancer incidence among Regular Army and national service veterans and non-veterans and also correlated cancer incidence with lifetime dose of dapsone received. The study concluded that there was neither definite evidence for an association between dapsone exposure and overall cancer incidence, nor an association between Vietnam service and overall cancer incidence.

1.1.3 Mortality of Vietnam Veterans Study

DVA completed a second Vietnam veteran mortality study in 1997.[7] This study compiled a comprehensive nominal roll of Vietnam veterans, including civilians, medical personnel, entertainers and female veterans. The mortality rate for all male military personnel and individual Service branches was compared to the mortality rate for the male Australian population. Mortality was assessed from 1980 to 1994, as this was the period in which data from the National Death Index, which was begun in 1980, was available. The mortality rate was significantly higher, SMR = 1.07 (95% CI 1.02, 1.12), compared to the male Australian population of the same age. There was statistically significant elevated mortality for all neoplasms, ischaemic heart disease, and suicide. The significant elevation in neoplasms was attributed mainly to elevated rates of prostate and lung cancers.

Among the Service branches, Navy veterans had the highest mortality rate, elevated by 37%, with significant elevations in mortality from neoplasms, circulatory diseases and external causes. Army and Air Force veterans did not demonstrate a significantly different overall mortality rate from the Australian population. However Army veterans did have a significant elevation of mortality from neoplasms.

1.1.4 Mortality of National Service Vietnam Veterans study

A supplementary study to the second Vietnam veteran mortality study was undertaken to examine mortality among national service veterans and non-veterans.[8] This analysis eliminated the healthy worker effect inherent when comparing a military population with the general Australian population. The length of follow-up was 22 to 29 years. The mortality rate from all causes was significantly higher in national service veterans, Relative Risk (RR) = 1.15 (1.0, 1.3). The death rate from all cancers was elevated but not significantly. The lung cancer rate was twice that among non-veterans, RR = 2.2 (1.1, 4.3), and cirrhosis of the liver nearly triple, RR = 2.7 (1.2, 6.4).

1.1.5 Morbidity of Vietnam veterans studies

A series of studies assessing the morbidity of Vietnam veterans was begun in 1996. A self-completed health questionnaire was distributed to 49,944 male veterans.[9] Greater than 80% of the veterans contacted completed the survey. The questionnaire asked veterans to assess their own health, and provide details of their marital status, health of their partner, and their children. The results of the survey were compared with expected community norms obtained from several surveys including the 1995 National Health Survey conducted by the Australian Bureau of Statistics.[10] The comparisons suggested that the health of Vietnam veterans and their families was worse than that of the Australian population.

A series of validation studies was undertaken to assess the reported elevated rates of illness. The number of validated cases of melanoma and cancer of the prostate were significantly higher than expected.[11] Also, there was an indication that chronic lymphatic leukaemia (CLL) and Non-Hodgkin's lymphoma were elevated.

1.1.6 Dioxin and potable water study

Given the higher mortality seen among Navy personnel, DVA commissioned the National Research Centre for Environmental Toxicology (NRCET) to investigate the potential exposure of Navy personnel to dioxins through potable water produced by evaporative distillation.[12,13] The report concluded that in the process of evaporative distillation of potable water, organochlorine pesticides and dioxins, if present in sea and estuarine water, would have co-distilled and been concentrated. This study demonstrated that ingestion and personal use of the potable water could have lead to exposure to these chemicals for Navy members.

1.1.7 Summary of findings overall

In summary, the Australian studies conducted since the mid-1990s have demonstrated a number of statistically significant elevations in mortality and morbidity among Vietnam veterans. Specifically, overall mortality and morbidity from neoplasms, circulatory diseases and external causes, such as suicide and accidents, were elevated when compared with male Australians of the same age.

A comprehensive literature review of the health effects of Vietnam service can be found in Appendix B.

1.2 History of the Nominal Roll of Vietnam Veterans

Prior to the commencement of any veteran health study, a nominal roll of the deployed cohort is compiled. The Nominal Roll of Vietnam Veterans (NRVV) was originally compiled for the veteran cohort component of the mortality studies published in 1997 by DVA and AIHW. The criteria for inclusion on the Nominal Roll were taken from the definition of 'Vietnam veterans' used for the 1997 studies. This definition broadly covered any member of the Army, Navy and Air Force and some civilian personnel who served on land or in Vietnamese waters during the

period of the Vietnam War, between 23 May 1962 and 1 July 1973. The roll listed each veteran's surname, up to two given names, service number, date of birth, one or more unit/ship/squadron and period/s of service. Compilation of the Nominal Roll was a major goal of the 1997 studies, ensuring that the studies were not restricted to those Vietnam veterans known to DVA.[7]

A Nominal Roll of Vietnam Veterans was published in both 1996 and 1997. Requests for additions and amendments to the Nominal Roll continued after its 1997 publication. More recently, DVA initiated work to refine and improve the level of data available for this series of Vietnam veterans' studies. This work resulted in over 4,600 changes to the Nominal Roll and is outlined in Chapter 3, although it does not yet contain all the information required to be published as a commemorative nominal roll.

1.3 Overview of the Third Australian Vietnam Veterans Mortality Study

The study presented in this report is the third mortality study of Australian Vietnam veterans. The first mortality study, (AVHS) described above, investigated mortality among Army veterans only. The second mortality study published in 1997 examined mortality of the three Service branches. This present study extends the 1997 study with seven more years of data.

1.3.1 Objectives of the study

The objectives of the mortality study are to:

- identify causes of death among Vietnam veterans for the period 1963 to 31 December 2001;
- compare the number of deaths among Vietnam veterans with the number of expected deaths based on mortality rates of the male Australian community;
- report any differences in mortality for specific causes of death, as highlighted by past studies and the literature review, from the Australian community; and
- investigate any differences in mortality between Navy, Army and Air Force Vietnam veterans.

1.3.2 Study design

The mortality study is a retrospective cohort study of male Australian personnel – Navy, Army, Air Force – who served in Vietnam between 23 May 1962 and 1 July 1973. The analysis determines mortality rates for the period from 1963 to 31 December 2001. The study compares the mortality rates of male Australian veterans with those of Australian males. All comparisons have been standardised by

age and calendar year of death. In addition, the study analyses whether mortality rates vary between different groups of Vietnam veterans.

1.3.3 Study implementation and ethical approval

Representatives of ex-Service organisations formed a Consultative Forum to represent the interests of Vietnam veterans (Appendix E), while a Scientific Advisory Committee (Appendix F) was established to oversight the scientific aspects of the study. The study was conducted by DVA in conjunction with AIHW (Appendix G).

A protocol for the studies in this series was completed in 2002 (Appendix B). It defined the study aims, methods of data collection and analysis, limitations of the study, reporting, and privacy and confidentiality considerations.

The study's Consultative Forum and Scientific Advisory Committee accepted the protocol. Successful applications for ethical approval were made to the DVA Ethics Committee and the AIHW Ethics Committee.

1.3.4 Definition of the veteran cohort

This report describes the mortality of male Vietnam veterans. For the purpose of this study, the Vietnam veteran cohort is defined as those persons from the following groups who saw service in Vietnam during the period between 23 May 1962 and 1 July 1973:

- all male Australian members of the defence forces and the Citizen Military Forces (CMF) who were allotted or deemed allotted for service in Vietnam;
- all Australian members of the defence forces who landed in Vietnam including those who were seconded to the Army of the Republic of Vietnam (ARVN), the United States Air Force (USAF), the United States Navy (USN) and any other allied service; and
- all members of the Australian Army Training Teams Vietnam (AATTV).

This definition excludes:

- members of the diplomatic corps;
- official entertainers and journalists;
- members of the Army of the Republic of Vietnam or any other army who have become Australian citizens subsequently;
- officers of the Repatriation Commission;
- members of the Australian Overseas Forces Fund;
- merchant seaman who sailed on ships chartered by the government for transport to Vietnam;
- civilian surgical teams;
- Australian citizens employed in Vietnam by overseas business organisations or governments; and

- civilian non-medical aid and charity workers and members of philanthropic organisations who were regarded as official.

The previous series of mortality and morbidity studies included some civilians as Vietnam veterans. This study is restricted to male military Vietnam veterans. The concluding date of 1 July 1973 was maintained in line with earlier studies, even though in 1997 coverage under the *Veterans' Entitlements Act (VEA) 1986* for the Vietnam War was extended to 29 April 1975. The chronology of service is discussed in Chapter 2.

1.3.5 Data collection

For each veteran who fulfils the study definition for the veteran cohort, the following data was extracted from the Nominal Roll of Vietnam Veterans to form the Study Roll:

- service number;
- surname;
- up to two given names;
- date of birth;
- period/s of service in Vietnam;
- ship/unit/squadron(s) in which the veteran served in Vietnam; and
- the veteran's branch of service.

For each person on the study roll, the following variables were sought to undertake a mortality analysis:

- vital status;
- date of death; or
- last known date alive; and
- cause of death: 4 digit ICD-10 codes.

The particulars of data collection are described in more detail in Chapters 3 and 4.

1.3.6 Specific causes of death

Overall mortality, in addition to mortality from specific causes, was investigated where it was considered that Vietnam veterans might differ from Australian males.

The specific causes of death (shown in Table 1-1) were selected through a review of the literature or through the concerns of veterans' organisations as potentially associated with chemical exposure; or they were suggested by previous studies of Australian Vietnam veterans.

Table 1-1: Causes of death of *a priori* interest

Cause of death	ICD-10 codes	Source
Infectious diseases	A00-B99	Literature review / Veterans' organisation
Cancers	C00-C97	Previous study: VVMS
Bladder cancer	C67	Literature review / Veterans' organisation
Brain cancer	C71	Previous study: National service study
Breast cancer	C50	Previous study: VVMS
Connective and Soft tissue cancer	C47-C49	Literature review / Veterans' organisation; and previous study: VVMS
Gastrointestinal cancers	C16-C21	Previous study: VVMS
Head and neck cancers	C01-C14	Previous study: VVMS
Hodgkin's disease	C81	Literature review / Veterans' organisation
Leukaemia	C91-C95	Literature review / Veterans' organisation
Lung cancer	C33, C34	Previous study: VVMS
Liver cancer	C22	Literature review / Veterans' organisation
Melanoma	C43	Previous study: Morbidity study
Multiple myeloma	C90	Literature review / Veterans' organisation
Non-Hodgkin's lymphoma	C82-C85, C96	Literature review / Veterans' organisation
Prostate cancer	C61	Previous study: VVMS / Morbidity study
Testicular cancer	C62	Literature review / Veterans' organisation
Thyroid cancer	C73	Literature review / Veterans' organisation
Ischaemic heart disease	I20-I25	Previous study: VVMS / Morbidity study
Digestive diseases	K00-K93	Previous study: VVMS / Morbidity study
Cirrhosis of the liver	K70	Previous study: VVMS / Morbidity study
Neurological diseases	G00-G99	Literature review / Veterans' organisation
Motor neurone disease	G12.2	Literature review / Veterans' organisation
Suicide	X60-X84	Previous study: VVMS / Morbidity study
Motor vehicle accidents	V02-V899	Previous study: VVMS / Morbidity study
Chronic obstructive pulmonary disease	J41-J44	Previous study: VVMS / Morbidity study

Numbers of deaths due to specific causes were determined by AIHW through matching with the National Death Index (NDI) and search of the Registries of Birth, Deaths & Marriages. These causes of death were coded using the International Classification of Diseases, Revision 10 (ICD-10) (see Table 1-1). These were compared with mortality data for all Australian males. The results are presented in Chapter 6.

1.4 Report structure

This introduction and Chapter 2 provide background to the study and the Vietnam War. The Study Roll is described in Chapter 3.

Chapter 4 describes how vital status was determined and the statistical methods used in the study. The characteristics of the Vietnam veteran cohort are presented in Chapter 5.

The analyses of mortality rates of male Vietnam veterans are presented in Chapter 6. Chapter 7 reviews the mortality findings, compares the findings with previous studies, summarises the study and formulates conclusions.

The literature review is reproduced in Appendix A. The study protocol for the study series is at Appendix B. Appendix C provides the results from focus group discussions with Navy and Army Small Ship veterans. Appendix E describes the accuracy of the matching of the study roll to the National Death Index. Appendix D presents the results of the analysis in mortality tables. Members of the study's Consultative Forum, the Scientific Advisory Committee and the project staff are listed in Appendices F, G and H respectively.

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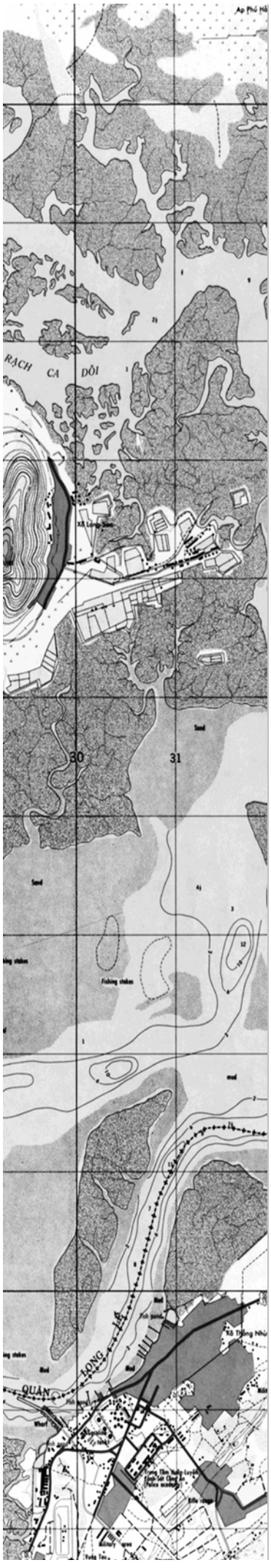


2

Australia's Involvement in Vietnam

Chapter 2 Australia's Involvement In Vietnam

The Oxford Companion to Australian Military History[1] states: "The Vietnam War was the longest and arguably the most diverse Australian military involvement in our history. It is also the least understood, and the most misrepresented." The aim of this chapter is to provide some background information for those unfamiliar with Australia's involvement in Vietnam. This chapter has been adapted from a more detailed discussion in the *Cancer Incidence in Australian Vietnam Veterans Study 2005*, a previous publication in this series of studies on the health of Vietnam veterans. The chapter begins with a background to the history, geography and climate of the Republic of Vietnam. A chronological overview of Australia's involvement in the Vietnam War is then presented and aspects of the variety of service experiences are summarised. The chapter concludes with a series of definitions, applicable under the *Veterans' Entitlements Act (VEA) 1986*, that differentiate service in Vietnam from continuous full-time service and reserve service in the Australian armed forces at that time.

2.1 Background – Republic of Vietnam

Information in this section is drawn from the *Mortality of Vietnam Veterans: The Veteran Cohort Study*.[2]

2.1.1 History

Vietnam is located on the eastern rim of the Indo-Chinese peninsula, stretching from the Chinese border to the southern tip of the peninsula. Following the French defeat at Dien Bien Phu, the Geneva Conference of 1954 was established to settle the political future of Indo-China and Korea. One of the outcomes was the establishment of the Republic of Vietnam. The Geneva Accords of July 1954 fixed a provisional Demarcation Line at 17 degrees north. The region south of this line formed the Republic of Vietnam, while the northern region became the Democratic Republic of Vietnam. Despite their official titles, the countries became more commonly known as 'South' and 'North' Vietnam respectively.

2.1.2 Geography and climate

Most of the country, north and south, consists of a rugged highland region, the Annamite Chain, a jungle covered mountain range interspersed in its southern portion with fertile plateaux. These plateaux slope gradually to the valley of the Mekong River in the west, but rise sharply in the east, leaving a narrow coastal plain cut by

spurs of the mountain chain. This region extends down from the northern borders to just north of Saigon.

The second important region in southern Vietnam is the Mekong Delta, a low level plain covering some 68,000 square kilometres which at no point is more than three metres above sea-level. The Delta is crisscrossed with streams, ditches and canals, which both irrigate the wet-rice paddy fields and drain the seasonal floodwaters.

The third region is the Central Lowlands which extend along the coast from Phuoc Tuy province, east of Saigon, north to the Demarcation Line. In general, this region is fertile and extensively cultivated, although the immediate 160 kilometres north from Vung Tau receives less rainfall than any other part of Vietnam and is somewhat infertile.

Rainfall and temperature in South Vietnam is determined by the seasonal alternation of the monsoons. During the summer monsoon, moist air flows inland from the sea, depositing heavy rainfall in its passage. The monsoon normally arrives in Vietnam by June each year. During the winter monsoon, cool air flows outward towards the sea, producing the country's dry season. In most parts of Vietnam the season is 'dry' only in comparison with the southwest summer monsoon. The winter monsoon normally reaches the Central Lowlands by early October and the Mekong Delta area by November and continues to blow until April.

Except in a few mountainous areas, high temperatures prevail throughout the year and the humidity is generally high and debilitating. The annual rainfall is heavy in all regions and torrential in many. In addition, typhoons off the South China Sea strike somewhere in Vietnam on average about ten times per year, usually between June and November.

2.2 Chronological overview

The following chronological overview relates specifically to Australian military involvement in the Vietnam conflict. This conflict is known by Australians and Americans as the Vietnam War. However in Vietnam this conflict is known as the American War.

In May 1962, the Australian government announced its intention to commit military instructors to Vietnam. The period of coverage under the *VEA* for the Vietnam War has been established as 31 July 1962 to 29 April 1975. This section briefly outlines events that occurred during this period.

The departure from Australia in July 1962 of the first contingent of the Australian Army Training Team Vietnam (AATTV) began the Australian Army's commitment to the Vietnam War. The Royal Australian Navy (RAN) contribution began in January 1963 when HMAS *Quiberon* and HMAS *Queenborough* were despatched to Saigon for a diplomatic port visit. The Royal Australian Air Force (RAAF) involvement formally commenced in 1963 with the first operational mission involving a relief flight with a Dakota transport aircraft of C Flight, No 2 Squadron, based at

Butterworth, Malaysia. This was followed in 1964 by the creation and deployment of RAAF Transport Flight Vietnam.

In 1965, the Australian involvement in Vietnam expanded. The Australian Army dispatched the 1st Battalion, The Royal Australian Regiment, and supporting units to Bien Hoa in South Vietnam. HMAS *Sydney* transported the bulk of the ground forces, and this voyage in May 1965 was the first of 25 voyages into the Vietnam War operational area.[3] Other Navy vessels escorted the troop carrier on these occasions.

The period 1966 to 1967 has been described as a period of consolidation.[4] Australian involvement was increased with the establishment of the 1st Australian Task Force that would contain two battalions, a Special Air Service squadron, and combat and logistical support units based at Nui Dat and the 1st Australian Logistic Support Group at Vung Tau. The task force included the Air Force's No 9 Squadron operating Iroquois helicopters, as well as support units. No 2 Squadron was also deployed in 1967, working with the United States Air Force at Phan Rang. In 1967, the Navy deployed HMAS *Hobart* as the first of a series of six-monthly destroyer rotations that continued until 1971.

The next phase of the war occurred from 1968 to mid 1969, when the task force was expanded with the addition of a third battalion. This period represents the peak strength of Australia's involvement.[5]

The task force reverted to a two-battalion structure in November 1970. This marked the beginning of a gradual withdrawal with the remaining two battalions returning to Australian in 1971 and the last of the support units and AATTV personnel departing in 1972. The Air Force squadrons also returned to Australia in 1971 and 1972. The Navy commitment began winding down with the return in 1971 of the last of the destroyer deployments, and concluding with the final voyage of HMAS *Sydney* in 1972. The last Australian troops, the Australian Embassy Guard Platoon, Saigon, were withdrawn in June 1973.

During the four weeks prior to the surrender of South Vietnam in 1975, Air Force personnel were involved in the delivery of humanitarian aid, movement of refugees and the transportation of war orphans. In April 1975, they undertook the final evacuation of staff from the Australian Embassy in Saigon.

Figure 2-1: Vietnam at the time of the Vietnam War, showing the division of the south into four separate corps or military regions

(Reproduced with the permission of Australian War Memorial)

2.3 Australian military involvement

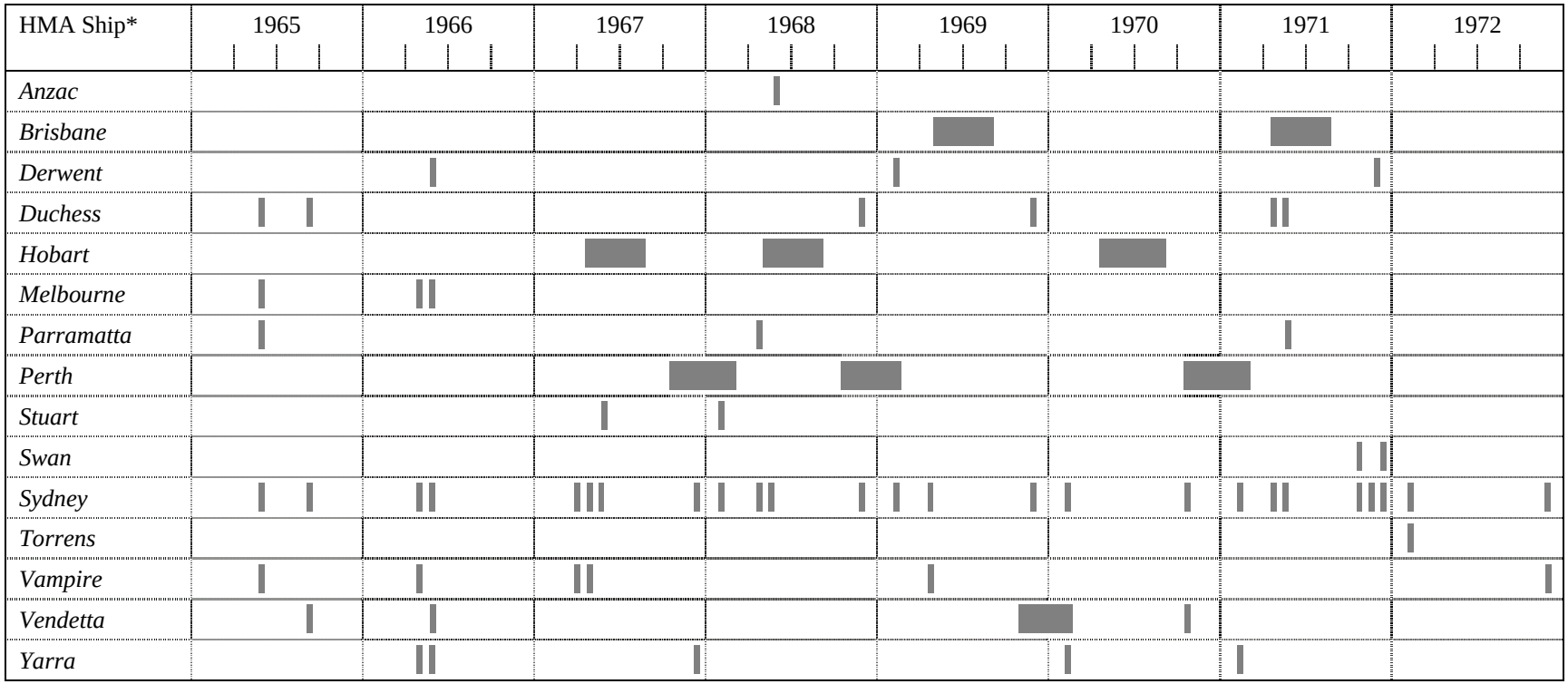
For many Australians, their perception of the Vietnam War has been informed through American culture and is influenced by some Australian commemorative practices that centre the Vietnam experience on particular sites and events along similar lines to earlier wars.[6] In this section, aspects of Australian service in Vietnam are summarised. The aim of this section is to provide an indication of the variety of experiences that made up Australia's military involvement in the Vietnam War.

2.3.1 Royal Australian Navy

Royal Australian Navy participation in the Vietnam War included working with the US Seventh Fleet 'on the gunline', transporting and escorting troops to and from Vietnam, and providing logistic support in the transportation of supplies and equipment. In addition, Navy personnel served on shore with both US and Australian units. Figure 2-1 indicates the periods in the Vietnam War operational area for HMA ships.

HMAS *Sydney* transported the bulk of the ground forces, and May 1965 was the first of 25 voyages into Vung Tau harbour.[7] A round trip from Australia to Vietnam generally took 20 to 24 days, with unloading and loading in the harbour at Vung Tau ranging between half a day to three days. HMAS *Sydney* was a British-designed aircraft carrier of mid-20th Century vintage and had been converted to a troop transport prior to the Vietnam War. HMAS *Sydney* was not designed for tropical conditions.[8]

A number of escort ships accompanied each voyage of HMAS *Sydney* to Vietnam. The following undertook escort duties: HMA Ships *Anzac, Derwent, Duchess, Melbourne, Parramatta, Stuart, Swan, Torrens, Vampire, Vendetta* and *Yarra*. Occasionally, an escort ship would make the round trip to and from Australia. However, the majority joined HMAS *Sydney* while on route to Vietnam. For example, HMAS *Vampire* was stationed at Singapore when called upon to escort HMAS *Sydney* into Vung Tau in 1969. After escort duties were completed, *Vampire* proceeded to the Philippines, to take part in exercises with other South-East Asian Treaty Organisation (SEATO) forces.[9] During this period, the Navy was committed to providing regular contributions to the British Commonwealth Far East Strategic Reserve and undertaking exercises with the SEATO where HMA Ships were required to maintain a high operational readiness.[10]



* Excluding the cargo vessels *Boonaroo* and *Jeparit*.
Dates sourced from ship logs, in conjunction with various published histories (refer Section 3.2.2).

Legend:

Troop or escort ship. These ships spent no more than 3 days in the operational area during each voyage.

Gunline ship. During each period indicated, the ships entered the operational area between 4 and 6 times, ranging from 7 to 39 days each time.

Figure 2-1: Periods in the Vietnam War operational area for HMA Ships

In 1967, the Navy deployed HMAS *Hobart* as the first of a series of six-monthly destroyer rotations that continued until 1971. Tasks undertaken during the first deployments included screening the US Seventh Fleet attack carriers in the Gulf of Tonkin and preventing the use of enemy supply routes off the North Vietnamese coast. After 1968, destroyer activity was confined to South Vietnam. Working 'on the gunline' involved cruising at least 5,000 yards (4,572 metres) from the coast, awaiting calls for fire against targets such as enemy troops, bunker systems and villages. Ships normally spent approximately one month on the gunline, followed by brief periods of leave and maintenance.[11] Four vessels served on the gunline: HMA Ships *Brisbane*, *Hobart*, *Perth* and *Vendetta*.

Chartered vessels from the Australian National Line were commissioned into the Royal Australian Navy, firstly in 1967 (HMAS *Boonaroo* for one voyage) and then in 1969 (HMAS *Jeparit* until 1972). Also in 1967, Navy personnel supplemented the civilian crew of the Australian National Line ship MV *Jeparit*. The mixed manning arrangements continued until the last voyage in 1972.[12]

On shore, Navy personnel served in Headquarters Australian Force Vietnam, 1 Australian Field Hospital, Clearance Diving Team 3, RAN Helicopter Flight Vietnam and with the Air Force's No 9 Squadron.

2.3.2 Australian Army

For those who served in the Australian Army, the Vietnam experience differed to the experiences of those who fought in earlier conflicts. Over the 10 year period of the Vietnam War, changes in leadership and the way the war was conducted resulted in different experiences for the men depending on when they were in the country. For example, AATTV was initially isolated in training centres but by the close of 1964 had moved into an operational advising role in the field.[13] Figure 2-2 shows the periods that Army Battalions were allotted for duty during the war years.

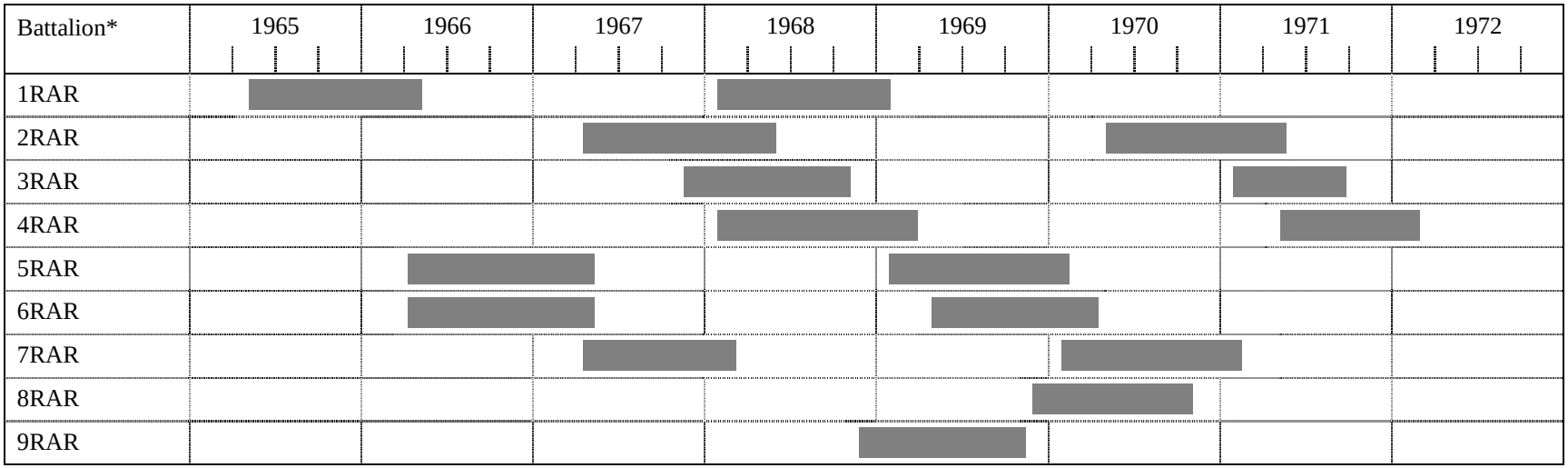
The Vietnam War saw a change in the nature of military tactics generally employed in operations. Advance, attack, defence and withdrawal were the skills and techniques of conventional warfare. These were replaced with new terminology such as search and clear, search and destroy, and cordon and search. Training included lectures on the appeal and threat of communist ideology. A doctrine of counter-insurgency was developed as a means of combating communist revolutionary warfare, which rarely presented clear targets or massed forces.[14] However, set-piece battles were still fought, for example the battles at fire support bases Coral and Balmoral in 1968. These battles involved the, arguably, conventional combination of infantry and tank actions against North Vietnamese troop formations rather then the counter-insurgency techniques generally employed against the southern Viet Cong guerrilla units.[15]

A cordon and search operation involved surrounding and closing off a village to prevent members of the Viet Cong from escaping, and setting up holding, screening and interrogation areas within the village. As the day proceeded, houses were searched, the villagers were screened and, if required, further interrogated. Identified members of the Viet Cong were taken prisoner. Medical aid, food and clothing were distributed.[16]

In comparison, a search and destroy operation was focussed on finding the enemy, their base camps and logistical infrastructure. The measure of success of the American attrition approach was in the enemy 'body count'. The Australian experience of one such operation was reported as

> a frustrating and arduous experience. Soldiers were rained on for days as they pushed through difficult country, crossed watercourses and occupied ambush positions in lice- and vermin-infested enemy camps. Skin infections from cuts and abrasions in the thorny thickets, along with leeches and ticks were a constant vexation.[17]

Another feature of the changing nature of military service was the increased reliance on a new style of air mobile warfare. This new style of warfare combined the use of helicopters with traditional artillery fire support. The primary Australian ground commitment was made up of Army combat units who spent 12 months in Vietnam before returning to Australia. Long periods were spent on operations, punctuated by short periods for rest and refit.[18] The frequency of operations, and the increased mobility available through the use of helicopters, has been argued as placing soldiers into longer periods of contact, or imminent danger of contact, with the enemy than was experienced by the majority of Australian soldiers in earlier wars.[19]



* Dates include period of travel to and from Australia. Dates sourced from McNeill I, Ekins A. "Appendix B Australian headquarters and units allocated for service in Vietnam, 31 July 1962-1 June 1973", *On the Offensive: The Australian Army in the Vietnam War, January 1967 – June 1968*. Crows Nest: Allen and Unwin, 2003. p458.

Figure 2-2: Periods the Battalions of the Royal Australian Regiment (RAR) were allotted for duty during Vietnam War.

2.3.3 Royal Australian Air Force

The different experiences of those who served in the Air Force in the Vietnam War could be broadly categorised in terms of those who were based in Vietnam and those who were based outside the operational area in places such as Butterworth, Malaysia or Richmond, Australia. Table 5-8 in Chapter 5 shows the categorisation of Air Force units according to where they were located.

RAAF Transport Flight Vietnam, subsequently redesignated No 35 Squadron, was based at Vung Tau. While moving supplies and people can appear routine, weather conditions were often atrocious, hostile fire was frequent and work routines were demanding with flying time sometimes double the rate that might be routine in Australia. This in turn placed high demands on ground staff.[20]

The role played by No 9 Squadron was considered the most dangerous of the Air Force deployment. Aircrew were frequently exposed to close range ground fire. Their operations involved hazardous flying conditions and small landing zones surrounded by tall trees. The helicopters were involved in the transportation of troops and the resupply of units in the field, evacuation of casualties and aerial spraying of defoliants.[21]

The Canberra bombers of No 2 Squadron were initially employed in high altitude bombing at night. However, after a few months, the squadron began low-level daylight bombing, involving visual bombing, where terrain, poor weather and ground fire often made such sorties difficult.[22]

In addition to aircrew, the Air Force deployment to Vietnam included support personnel. These included teams from No 5 Airfield Construction Squadron, the airfield defence guards, and technical airmen, some of whom were posted to Australian Army units. In addition, Australian Air Force personnel served with US Air Force units.

The Australian Air Force experience of the Vietnam War for those based outside the operational area included the provision of courier services and aeromedical evacuations between Australia and Vietnam. These Hercules flights began in 1964 and had to contend with a number of difficulties. In the early period of the Vietnam War, Australian aircraft were unable to fly through Indonesian airspace, necessitating a circuitous route of extended flying time and consequent fatigue and reduced safety for the crew. The route also proved an arduous experience for medical staff and patients as the early flights were not insulated against engine noise and interior temperatures were variable. Conditions were improved with the arrival of a newer model Hercules. Evacuation flights continued until 1971 and the last of the courier service flights returned to Australia in 1972.[23]

2.4 Other groups

A number of other groups have been recognised for service during the Vietnam War. These include Army nurses, SEATO medical and surgical teams, war correspondents, official entertainers and members of philanthropic organisations. Details of the experiences of these groups have not been included here as the study protocol (refer Appendix A) is limited to male defence force personnel.

2.5 Definitions of service

The following definitions are a summation of the definitions contained in the *VEA*. Within the Veterans' Affairs Portfolio, this legislation assists the Repatriation Commission and the DVA to carry out government policy and implement programs to fulfil Australia's obligations to war veterans and members of the Australian Defence Force, and their dependants. Within the parameters of this study, the *VEA* definitions have been used to differentiate the veteran cohort from the general military population of the period.

2.5.1 Operational area

The operational area during the Vietnam War is defined in Schedule 2 of the *VEA* as the area of Vietnam, including the waters contiguous to the coast of Vietnam for a distance of 185.2 kilometres (100 nautical miles) seaward from the coast. The period during which Vietnam service was active is specified to commence from 31 July 1962 to and including 11 January 1973. In 1997, service rendered in the operational area 'Vietnam (Southern Zone)' between 12 January 1973 and 29 April 1975 was also deemed as warlike service.

2.5.2 'Allotted for Duty' and 'Operational Service'

Under the *VEA*, the terms 'Allotted for Duty' and 'Operational Service' are interpreted as meaning:

- **Allotted for Duty** means a person or unit of the Defence Force that was allotted for duty in an operational area. Allotment may be retrospective or prospective, and occurs via a written instrument issued by the Defence Force; and
- **Operational Service** is rendered where a person is allotted for duty and serves in an operational area. Current use of this term is not the same as normal posting procedures used in the Defence Force to move members from one unit to another.

Retrospective allotment

In 1986, a number of Navy and Air Force units were retrospectively allotted for duty in the Vietnam operational area. Retrospective allotment acknowledges that the presence of an individual, or a ship, unit or squadron, in the operational area

was for the purpose of the conduct of the war. It is possible to be in the operational area but not deemed allotted. For example, HMA Ships travelling between Hong Kong and Thailand may pass within 100 nautical miles of the Vietnamese coast but are not eligible for inclusion in the study.

Within the parameters of this study, retrospectively allotted Navy units included the HMA Ships *Anzac, Boonaroo, Derwent, Duchess, Jeparit, Melbourne, Parramatta, Queenborough, Quiberon, Stuart, Swan, Sydney, Torrens, Vampire, Vendetta* and *Yarra,* which served logistic or escort duty. It also included RAN personnel who served as crew members of the MV *Jeparit.*

For the Air Force, the 1986 retrospective allotment included individuals who entered the operational area in an operational or support role but were posted to a squadron or unit that was based in Malaysia or Australia. The list of eligible squadrons and units is shown in Chapter 5, Table 58.

Retrospective allotment was also granted to military personnel from all three branches of the Service who undertook staff or equipment visits or inspections, or public relations, familiarisation or welfare visits to the Australian forces in Vietnam.

2.6 Summary

This chapter has provided some background information to readers unfamiliar with Australia's involvement in the Vietnam War. Australian involvement was formally announced in May 1962. There was a gradual build up of numbers, peaking in 1968, followed by a gradual decline until the bulk of the troops had departed by the end of 1972. The last of the Australian troops left in June 1973. Air Force personnel participated in humanitarian flights and the final evacuation of Australian and Vietnamese civilians in 1975.

Australians who served in Vietnam returned with no sense of defeat, with the final collapse of the South Vietnam forces occurring four years after the Australian task force began withdrawing.[24] For the general population of Australia, the image of the fall of Saigon, so often repeated in documentaries, American TV dramas and films, has become a defining image of the Vietnam War. It is an image alien to the experiences of Australian Vietnam veterans, with the exception of a small number of RAAF personnel involved in the airlifts of 1975. In addition, the American perceptions and dramatisations of prisoners of war have no equivalent in the Australian experience, as there were no Australians taken prisoner in the Vietnam War.[25]

The experiences of the Navy, Army and Air Force personnel were varied. In this chapter, we have broadly categorised the Navy and Air Force experiences. These categorisations have been taken into consideration when designing the study and conducting the analysis. However, the inability to broadly categorise the Army experience limits the degree to which sub-group analysis can be undertaken.

For the purposes of this study, definitions applicable under the *VEA* have been drawn upon as a means of differentiating the veteran cohort from the general military population of the period.

In the next chapter, further detail is provided on the development of the study roll.

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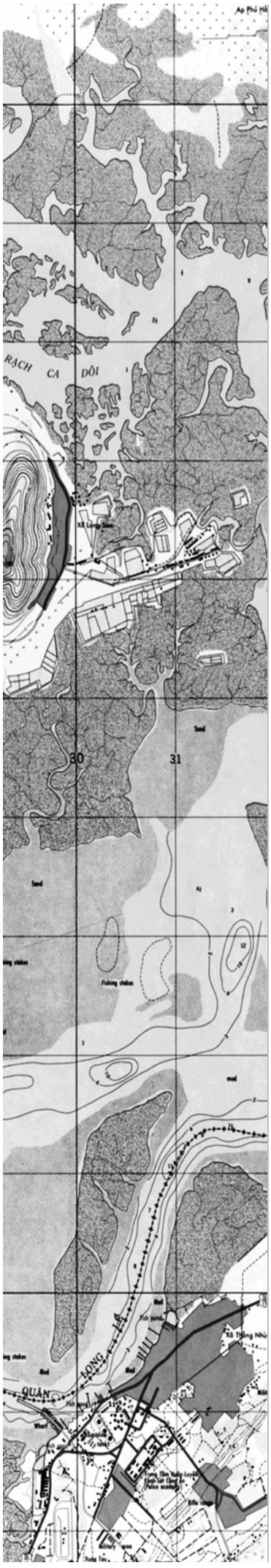


3

The Study Roll

Chapter 3 The Study Roll

The roll compiled for this study, known as the Study Roll, was drawn from the Nominal Roll of Vietnam Veterans (NRVV) that is currently maintained by the DVA. The Study Roll is a list of all those currently identified as conforming to this study's definition of 'Vietnam veterans' (see Section 1.3.4).

3.1 Completeness of the Nominal Roll

The NRVV was the first consolidated nominal roll produced of Australian veterans of the Vietnam War and included both military and civilian personnel. A number of discrete rolls existed prior to 1996 and military historians are still mining archival material in order to produce and publish unit and ship histories for the Vietnam War period. These histories often contain rolls of personnel who served in those units or ships.

3.1.1 Original data sources

The mortality study published in 1997 reports that the data for the NRVV was originally sourced from the DoD. The rolls of Navy and Army personnel were developed from lists supplied by Navy Office and Army Office respectively. For Air Force, a computer file containing 3,728 Air Force personnel who met the eligibility criteria for the study formed the original source document. As it contained fewer names than the official figure, missing names were identified by cross-checking the computer file against other published lists and each potential addition was checked and confirmed as having served in Vietnam by referring to his personal file from Air Force archive. Other names were added from lists provided by the Royal Australian Air Force Historical Section.[1]

3.1.2 Work undertaken since 1996

The NRVV was first published in 1996. Individual veterans, historians and ex-Service organisations reviewed the publication and forwarded notifications of errors and omissions. Further work to improve the Nominal Roll was undertaken by DVA, although it does not yet contain all the information required to be published as a commemorative nominal roll. A summary of additions and deletions is provided in Table 3-1 at the end of this section.

Notifications from individuals and ex-Service organisations

In the 1996 version of the NRVV, DVA requested all readers who identified errors or omissions in the roll to contact the relevant branch of the DoD. That Department verified the request and forwarded the required information to DVA for incorporation into the roll. The roll could only be amended with the written authority of the DoD.

When the intention to conduct the *Third Vietnam Veterans Mortality Study* and *Cancer Incidence Study of Vietnam Veterans* was announced in 2002, there was an increase in the number of inquiries from the veteran community directed to DVA. The DoD was approached for assistance if the enquiry identified a possible error or omission.

Since 1996, veterans, historians and ex-Service organisations have identified over 800 errors or omissions that resulted in amendments to existing entries or the addition of new entries to the NRVV.

Research conducted by DVA

DVA adopted two strategies for improving the completeness of the NRVV in preparation for this study.

Firstly, a number of ex-Service organisations were approached for their advice on areas of the Nominal Roll requiring additional work. While all notifications were acted upon, of specific relevance to this study was the work undertaken by the various state-based Vietnam Veterans Logistic Support associations. Their work confirmed a gap in the Navy data identified in the 1997 mortality report. Records for some personnel who served in logistic support ships such as HMAS *Sydney* and the ships that performed escort duty, had not been collated into the roll. Navy Office believed that these men had left the Service before the computer system was implemented in the late 1960s and their records were therefore not entered into it.[1]

To improve the Navy component of the Roll, archival materials, in the form of Next of Kin Lists, were identified and a selection cross-checked with the Nominal Roll. Possible additions to the Nominal Roll were confirmed against personnel cards held at the National Archives of Australia (NAA).

This exercise resulted in the addition of 1,046 veterans to the NRVV and consequently to the Study Roll. In addition, 2,358 additional voyages to Vietnam for veterans already listed were added to both rolls.

The second strategy adopted by DVA to improve completeness of the roll was to conduct a data review of the Nominal Roll to identify incomplete details and duplicate names that could not be successfully incorporated into the data matching stage of the study. This review identified records of 42 people with only initials for forenames, 130 who had no date of birth, and 386 who had incomplete service details. The DoD was approached to provide the missing information. Of these,

one incomplete forename and 65 with incomplete service details remain unresolved.

The data review also highlighted 34 records that appeared to be duplicates, both within a Service branch and across Service branches. AIHW further identified 13 possible duplications. The incorrect listings were removed from both the Nominal Roll and the Study Roll. Thirteen people were identified as having served in more than one branch of the armed forces in Vietnam. These 13 served in Vietnam initially in one branch, discharged and subsequently enlisted in another branch of the armed forces and returned to Vietnam. These names were retained in each of their respective Service branches in both the Nominal Roll and the Study Roll.

Other names were removed from the Nominal Roll as a consequence of research undertaken to improve the roll. Identified RN and RNZN entries were removed and Army and Navy personnel who were identified as either not departing Australia as planned or departing Australia but not crossing into the Vietnam War operational area. As this made them ineligible for inclusion on the NRVV, and consequently the study, their names were removed.

Table 3-1: Summary of additions and deletions for male military personnel

	Army	Navy	Air Force	Total
2nd Mortality Study & 1996 Nominal Roll	41,388	12,376	4,438	58,202
Additions between 1996 & 1997	29	127	130	286
1997 Nominal Roll	41,417	12,503	4,568	58,488
Additions to Nominal Roll	176	1,089	21	1,286
Deletions from Nominal Roll	1	4	0	5
Nominal Roll available for Study Roll	41,592	13,588	4,589	59,769
Removal of Roll of Honour	495	8	17	520
Deletions from both Nominal & Study Rolls	13	42	2	57
Final Study Roll	41,084	13,538	4,570	59,192

3.2 Creation and development of the Study Roll

Records that conformed to this study's definition of 'Vietnam veteran' (see Section 1.3.4) were drawn from the NRVV as at 2 September 2003 for data matching. These data were supplemented with period of time in Vietnamese waters for Navy and Army 32 Small Ship Squadron personnel.

3.2.1 Structure of the Study Roll

The following fields were drawn from the NRVV for male military personnel:

- Service number;
- surname;
- up to two given names;
- date of birth;
- period/s of service in Vietnam;
- ship/unit/squadron(s) in which the veteran served in Vietnam; and
- branch of Service.

The Nominal Roll includes the names of 520 people on the Roll of Honour that is maintained by the Australian War Memorial. These 520 people died in service and did not return from the war. Their names were removed from the Study Roll since their death preceded the start of the study period.

3.3 Accuracy of data

Since the publication of the NRVV, over 800 notifications of errors and omissions that were subsequently verified by DoD. This can be interpreted as roughly a 1% error rate in the accuracy of the original Nominal Roll data. However, this does not eliminate the possibility of systematic errors such as that found in the Navy data during the 1997 study. In preparing for this series of studies, potential areas of systematic error were assessed.

3.3.1 Navy

To prepare the Navy component of the Nominal Roll for the study, the identified gap in the data reported in the *Mortality of Vietnam Veterans: The Veteran Cohort Study* had to be quantified and assessed. Sections of archival material known as 'Next of Kin Lists' were cross-checked against the Nominal Roll. These sections were chosen from a range of years and included each of the pre-identified categorisations – troop, escort and gunline. The results of this assessment are summarised in Table 3-2.

Table 3-2: Accuracy of Navy data

Category; Year/s	Number checked	Matched		Insufficient detail to match		Missing from NRVVa		On NRVVa but missing this voyage	
			%		%		%		%
Troop; 65, 67, 68, 69	335	240	71.6	7	2.0	26	7.8	62	18.5
Escort; 71	239	231	96.7	0	0.0	0	0.0	8	3.3
Gunline; 68-69	344	337	98.0	0	0.0	0	0.0	7	2.0

[a] Nominal Roll of Vietnam Veterans

As a consequence of the data assessment, a data capture process was undertaken to cross-check all available 'Next of Kin Lists' prior to 1970 for troop and escort ships (refer Section 3.1.2). The data assessment identified two systematic errors in the Navy data. Firstly, the service details of existing entries did not fully reflect all service on board HMA Ships that entered the operational area. The pattern of this missing service did not conclusively explain the presence of the error. Possible additional service details for approximately 2% to 3% of those on board the gunline ships and the troop and escort voyages between 1970 and 1972 remain unresolved.

The second systematic error that emerged during the data assessment relates to the presence on the Nominal Roll of personnel who were not confirmed on board when the ship passed into the operational area. Acknowledging that the 'Next of Kin Lists' were not necessarily a perfect record of who was on board while the ship was in the operational area, a sample of the unconfirmed names was cross-checked against personnel cards at NAA. The results are detailed in Table 3-3.

Table 3-3: Inconsistencies between Nominal Roll of Vietnam Veterans and 'Next of Kin Lists'

Category; Year	NRVV [b] total on board	Next of Kin list does not confirm	Personnel card at NAA [a] confirmed on board	does not confirm		No card
					%	
Troop; 67	685	18	5	7	1.0	6
Escort; 66	325	24	5	18	5.5	1
Escort; 69	318	31	26	4	1.3	1

[a] National Archives of Australia

[b] Nominal Roll of Vietnam Veterans

The 'Next of Kin List' for 'Escort; 69' was missing two pages, hence the high number of confirmations from the personnel cards when compared to the other two voyages. The 'Next of Kin Lists' are a good archival source for triangulation of existing data, but they are not in themselves the ultimate source for complete crew lists. In a similar fashion, posting data may not accurately reflect who was on board at a particular time. For example, the personnel cards for 'Escort; 66' record 10 names from the Nominal Roll as being on leave while the ship to which they were posted was in Vung Tau. It is not clear why 'Escort; 66' had a higher number on leave than the other two voyages (numbering one and two respectively). As the Nominal Roll was originally created based on ship postings, it is expected that all voyages will have a small percentage (estimated to be approximately 2% overall) of personnel who were not physically on board when the ship passed through the Vietnam War operational area. A subset of these would not be eligible for inclusion if they had no other eligible service.

3.3.2 Army

A review of data held on the RAR 7th and 8th Battalions was prompted by feedback from the battalion associations that identified a number of errors and omissions. The percentage of errors requiring amendments to the data ranged between 2.3% to 3.6%. The amendments included people posted to 1 Australian Reinforcement Unit (1ARU) who were subsequently shown on their Record of Service as posted to one of the battalions. This second posting had not been included in the original data collection process. A further percentage of the notifications could not be conclusively proved, as their period in the battalion was not shown on the individual Record of Service, even though their names were listed on the 'Australian Army Orders Unit Citation' or other DoD material. Table 3-4 summarises the results.

Table 3-4: Accuracy of 8RAR and 7RAR data

	Nominal Roll	Additions		Amend Personal		Amend Service		Inconclusive	
			%		%		%		%
7RAR	2,263	15	0.7	10	0.4	43	1.9	49	2.1
8RAR	1,122	6	0.5	10	0.9	30	2.7	20	1.8

This assessment of the accuracy of the Army data has shown that the number of omissions is still considered low. The degree of error in the service details (range 1.9% to 2.7%) should be combined with the 2% inconclusive factor when assessing accuracy of the service data. This places the possible degree of error in the Army service details at around 4%.

3.3.3 Air Force

The 1997 mortality report estimated that at least 80% of Air Force personnel were represented in that study. It is reported that this comprises personnel who were posted or attached to Vietnam units, those additional members who qualified for the Vietnam Medal, those posted for temporary duty in the area, those seconded to US units and others such as Forward Air Controllers.[1]

It was considered that gaps in the data were confined to personnel who were based in Australia or Malaysia and took part in the regular courier and medevac flights to and from Vietnam. It was further considered that this data could only be accurately retrieved from individual flight logbooks. This was beyond the scope of the current series of studies.

A review of Nominal Roll entries for 36 and 37 Squadrons highlighted inaccuracies in the existing Air Force data. Their service details showed that entries had been added to the Nominal Roll using, in some cases, the dates posted to the squadron or, in other cases, the departure date of the their first flight to Vietnam and the return date of their last flight to Vietnam. Of the 302 separate service entries, 286 did not accurately reflect time in Vietnam. These squadrons are included in overall analyses but could not be included in analyses considering time in Vietnam.

Aside from notifications from individuals, historians and ex-Service organisations since the publications in 1996 and 1997, no additional work has been undertaken on the Air Force component of the Nominal Roll.

3.4 Total number in the veteran cohort

In line with this study's definition, and following work undertaken by DVA and AIHW to develop the Study Roll, the names of 59,179 armed forces personnel were identified for data matching. This is an overall increase of 1,513 since the last mortality study of Vietnam veterans published in 1997. As this is the second cancer incidence study of Army veterans, it should be noted that this is an increase of 810 Army veterans since the 1992 study.

Table 3-5: Number of veteran cohort by branch of Service

Service	Number	%
Navy	13,538	22.9
Army	41,084	69.4
Air Force	4,570	7.7
Total	59,179 [a]	100.0 [a]

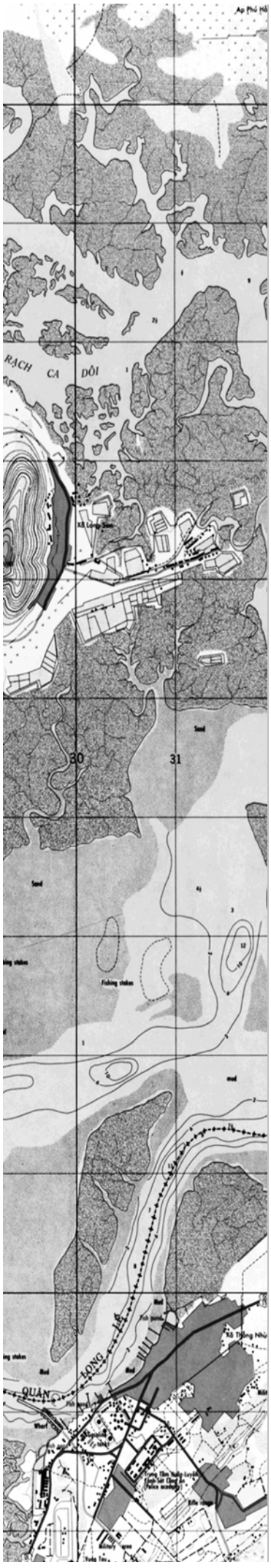
[a] 13 men served in more than one branch.

Table 3-5 shows that the study includes 41,084 Army, 13,538 Navy and 4,570 Air Force veterans who served in Vietnam. This includes eight veterans who served in both Army and Navy, and five veterans who served in both Army and Air Force.

Chapter 4 describes the methods for determining vital status of the veteran cohort and Chapter 6 details the numbers eligible for inclusion in this cancer incidence study.

References

1 Crane PJ, Barnard DI, Horsley KD, Adena MA. Mortality of Vietnam veterans: the veteran cohort study. A report of the 1996 retrospective cohort study of Australian Vietnam veterans. Canberra: Department of Veterans' Affairs, 1997.



4

Methods

Chapter 4 Methods

In the conduct of a mortality study such as this one, three tasks are of paramount importance: compiling the Study Roll, determining the vital status of the cohort and determining the cause of death of the deceased veterans. This chapter will discuss data sources and methods used for determining the vital status, and methods for calculating mortality rate ratios for selected causes of death among subgroups within the cohort.

Determining whether a veteran is alive or dead (vital status) and, if dead, their date and cause of death, was the prime objective of this study. From this data the population at risk is calculated, that is, those veterans alive at any one time, and in turn, the mortality rates by cause for the cohort is determined.

A comparison between the mortality rate in Vietnam veterans and that of the male Australian community was carried out for a range of specific causes and groupings of causes of death. Causes of death were chosen because the study protocol identified them as being of particular concern (*a priori*), or because they were common in the Australian population or among the Vietnam veterans.

The statistical analysis of the Vietnam veteran cohort employed a standard method for cohort studies. It involves calculating the expected number of deaths of study participants in each year by applying the age and sex-specific mortality rates of males in the Australian community to the study participants alive at each year from 1963 to 2001. The observed number of deaths among the study participants was then compared to the expected number of deaths to produce a Standardised Mortality Ratio (SMR), and tested for any statistically significant differences.

4.1 Vital status and sources of data

Determining vital status was carried out in part using computerised matching of veterans' records with information in large national databases, such as the AIHW National Death Index (NDI), the electoral roll, DVA databases and other registries. Primarily, the Study Roll was matched against DVA databases, as this contained information about both living and deceased veterans.

Registration of deaths in Australia is compulsory and is the responsibility of the State and Territory Registrars of Births, Deaths and Marriages (RBDM). All veterans who died in Australia should be registered with the RBDM but the quality of information (e.g. the lack of computerised records in the early years, changing names of veterans, incomplete date of birth) does not always allow for precise confirmation of death. Therefore, multiple sources of information are

needed to maximise coverage and to get the best evidence regarding the vital status of each veteran.

Tables 4-1 and 4-2 summarise the different sources of vital status data used in this study. Table 4-1 shows the period covered for death information and Table 4-2 shows the sources used to determine events indicating whether a study subject is alive and on what date.

Table 4-1: Summary of sources of vital status — death

Date of death	Source
On active service in Vietnam	Department of Defence
In service, post-Vietnam	Department of Defence
Between 1963 and 1980	Australian State and Territory Registries of Births, Deaths and Marriages
After 1980	AIHW National Death Index
Since Vietnam service	Veterans' Affairs Client Data Base
After 1984	Health Insurance Commission Medicare database

Table 4-2: Summary of sources of vital status — alive

Action indicating the subject is alive	Assumed alive on the date of	Source
Receiving a Veterans' Affairs pension	their last payment	Veterans' Affairs Client Data Base
Made a Medicare claim	their last claim	Health Insurance Commission Medicare database
Developed cancer	date of registration	National Cancer Statistics Clearing House
Enrolled to vote	extraction of the roll	Electoral Commission rolls
Departed or arrived in Australia	departure/arrival	Department of Immigration, Multicultural and Indigenous Affairs

4.1.1 Department of Veterans' Affairs Client Data Base

DVA maintains a Client Data Base, which provides a central source of information about veterans who have claimed for any benefit provided by DVA. The Client Data Base record contains information on surname, given name, other initials, date of birth, date of death and some information on military service and the service on which a claim was determined. However, any other service is not always recorded.

Data quality

Because the personal data, names and pension details on the Client Data Base are regularly used and referred to in correspondence with veterans, these details are believed to be current and accurate. However, details of military service are less reliable and often incomplete as this database was originally intended for payment management, not military service tracking. For this reason, the Client Data Base was not used as a source of data on service details. Such details were obtained from the relevant service records office. However, Service numbers, where recorded, provided confirmation of correct matches from other sources. Pension related details were not accessed for the purposes of this study.

The DVA database has no information on the vital status of Vietnam War veterans who have not claimed for any benefit provided by the Department.

4.1.2 The National Death Index and the National Mortality Database

The National Death Index (NDI) is a database located at the AIHW. It contains name-identified records of all deaths in Australia registered after 1980. In excess of 2.5 million records are contained in the database. The RBDM in each Australian State and Territory supplies the information for this database. As registration of death is a legal requirement, the database is virtually complete for deaths in Australia. The data available for matching in the NDI covered the dates of death for the period from 1980 to 2003 for all States and Territories, and some 2004 data.

Data quality

The data quality of the NDI varies considerably between States and Territories and over time within each State and Territory. Data quality and completeness affected the matching strategy and the results of data matching for this study. The NDI does not have full dates of birth for:

- Queensland for the period 1980–1996 inclusive;
- New South Wales for the period 1980–1992 inclusive; and
- Victoria for the period 1980–1989 inclusive.

In these situations, a year of birth is derived from the date of death and the age at death.

Within the NDI, there are inconsistencies in the way names are recorded. Data standardising procedures were therefore applied to the NDI in order to reduce inconsistencies. Examples of this standardising procedure used with matching to the NDI and other databases are provided in Section 4.3.1.

While personal information is usually provided about the deceased by the next of kin, acquaintance or official of the institution where the death occurred, information on the cause of death is variously supplied by family doctors, hospital residents, pathologists, or coronial staff. This large range of information sources

contributes to the variable quality of cause of death data and a degree of inaccuracy overall. This situation also applies to the data held by the State and Territory RBDMs.

4.1.3 The electoral roll

The electoral roll was supplied by the Australian Electoral Commission (AEC). It was extracted as at August 2003 for all States and Territories. The roll contains over six million records of male Australians. Most living Australian citizens over the age of 18 appear on the roll.

Enrolment on the electoral roll is compulsory for all Australian citizens who have attained 18 years of age. However, the following people are not entitled to have their name included or retained on any electoral roll:[2]

- the holder of a temporary visa;
- an unlawful non-citizen under the *Migration Act 1958*;
- a person of unsound mind;
- a person serving a sentence of five years or longer for an offence against the law of the Commonwealth or of a State or Territory.

While the first two points do not pertain to this study cohort, the last two potentially could.

Data quality

There are known to be multiple registrations on the electoral roll of persons across States and Territories. This occurs if a person moved between States and Territories of Australia and their previous entry had not been removed from the electoral roll.

Recorded names may not necessarily be legal names and there are persons who have died but their deaths are not known to the AEC.

4.1.4 Health Insurance Commission

The Health Insurance Commission (HIC) has administered Medicare, Australia's national health insurance scheme, since its introduction on 1 February 1984. The scheme provides free access to hospital services for all Australian residents and subsidises the costs of a range of other medical services.[3]

Two databases are maintained by the HIC: one of persons enrolled in the Medicare scheme; and one for claims processing. As at 30 June 2003 there were 10,282,188 males enrolled with Medicare, which is 104.1% of the estimated resident male population of Australia.[4] The excess is because Medicare enrollees include some persons who are not Australian residents (e.g. long term visitors, greater than six months, and eligible short term visitors).

Data quality

When notified, the HIC records the date of death or the date of departure from Australia of persons on its database, but more commonly the records become inactive.

The HIC only keeps records of claims made in the last five years. Older claims are deleted from the database. As only recent and active records are kept, matching with HIC Medicare data can reliably ascertain that a person is alive provided they have made a claim in the last five years. Conversely, as information on deaths and departures from Australia is only gathered if the information is proffered, the finding of this type of information is less reliable than other sources.

4.1.5 National Cancer Statistics Clearing House

As cancer is a notifiable disease in all States and Territories, the registries compiling this information can be used as an additional check for vital status. The data includes clinical and demographic information about people with newly diagnosed cancer. This information is obtained from hospitals, pathologists, radiation oncologists, cancer treatment centres, nursing homes and RBDMs.

The AIHW is responsible for the national collection of cancer incidence statistics through the National Cancer Statistics Clearing House (NCSCH). The NCSCH receives data from individual State and Territory cancer registries on cancer diagnosed in residents of Australia. National statistics are available for all years from 1982 to 2000. The database is updated annually.

Data quality

The important data items for this purpose are names, date of birth and date of diagnosis, that is known date alive. Surname was available for all records, first name for 99.9% of the records, second name for 52%, date of birth for 99.9% and date of diagnosis for 99.9%.

4.1.6 Other data sources

The Directorate of Honours and Awards in the Department of Defence maintains a database of those servicemen and women who have applied for a service medal or award. The database contains service number, surname, given names, date of birth and some dates of death for service personnel who have applied for a service medal or award or in the case of a deceased veteran, their family members have applied for a posthumous award. The Department of Defence also administers the Central Army Records Office (CARO), which maintains the personnel service records for all Army personnel.

The Department of Immigration, Multicultural and Indigenous Affairs (DIMIA) maintain an electronic Movement Reconstruction database of all persons arriving in and leaving Australia from 1980 to the present. DIMIA were able to provide

information on date of death, if known, and date of last movement, that is the last known date alive.

4.2 Quality of the Study Roll

The Study Roll of Australian Vietnam veterans, as described in Chapter 3, contains details of 59,179 male veterans. Missing or incomplete data items reduced the chances of matching the Study Roll records with the NDI or other databases. Thus, failure to match with the NDI may falsely indicate that the veteran is alive (false negative) or, conversely, an incorrect match may give the false impression that the veteran is dead (false positive). Such errors may arise simply as a result of missing or incomplete data in the source record.

Table 4-3, shows that missing and incomplete data were a minor concern for the Study Roll. All first forenames were recorded. Most second forenames were recorded in full but for 10% of cases this data item was missing although the percentage of missing second names compared with those who had no second names to record is unknown. There were no records with missing dates of birth. In all, the quality of the Study Roll was considered good for matching purposes.

Table 4-3: Frequencies of incomplete and missing data on the Study Roll

Service branch	Total on Study Roll	Initial only for first name	No second forename (%)	Missing date of birth
Navy	13,538	0	1,326 (9.8%)	0
Army	41,084	0	4,077 (9.9%)	0
RAAF	4,570	0	448 (9.8%)	0

4.3 Record linkage between the Study Roll and selected data sources

The study incorporated a wide range of data matching techniques to accommodate the various data holdings. Some matching involved manual searches of paper or microfiche records. Electronic matching was used whenever possible, using both 'deterministic' and 'probabilistic' techniques. 'Deterministic matching' involves the use of registration numbers or a specific combination of data elements to match two records. 'Probabilistic matching' is more flexible and involves linking records that are thought to relate to the same individual. The process is described as 'probabilistic' because for each linkage there is an associated degree of certainty that the records are correctly paired, the same as if the process were carried out manually.[5]

The software package[6] used for 'probabilistic matching' calculates the likelihood of a correct linkage, that is, that the records represent the same individual. The higher the likelihood of a correct linkage, the higher the weight accorded the match. Below a designated cut-off value, the weight of the match is too low to be considered a correct linkage and the records linked are considered to be different individuals.

4.3.1 Matching by DVA

DVA was responsible for matching the Study Roll of Australian veterans of the Vietnam War with information indicative of vital status of veterans available within DVA and with the electoral roll.

Matching with the DVA Client Data Base

For the matches with the DVA databases, only an exact match of surname, forenames and day, month and year of birth or an exact match of surname and service number were permitted. These criteria were more stringent than those for matching with the NDI and the electoral roll, where a probabilistic approach was taken, and thus were given precedence.

The Study Roll was matched with the Client Data Base, which contains records of veterans receiving payment of a pension or allowance from the DVA and records of client deaths. If there was a match, the veteran was recorded as being alive at the date of the last payment or if a death was recorded, the veteran's date of death, was entered onto the Study Roll.

Matching with the electoral roll

The Study Roll and the electoral roll were standardised to improve the likelihood of successfully matching veterans' details. This meant that apostrophes, hyphens and other miscellaneous characters were removed from surnames, and dates of birth and dates of death, where available, were presented within valid ranges. Soundex and New York State Intelligence Information System (NYSIIS) coded versions of the standardised surnames were created which allows for variations in spelling of names (e.g. Smith, Smithe, Smythe). Standard versions of first names were added to all files (e.g. Robert for Bob and Rob). If there was a match, the veteran was assumed alive.

4.3.2 Matching by AIHW

The Australian Institute of Health and Welfare was responsible for:

- identification of potential duplicate records in the Study Roll;
- matching with the NDI;
- matching with the NCSCH for all States and Territories except Victoria;
- supervising the matching with the Victorian cancer registry; and
- supervising the matching with the State and Territory RBDMs.

Identification of potential duplicate records and matching with the NDI, the NCSCH and the Victorian cancer registry were undertaken using 'probabilistic' matching techniques.

Matching with the NDI, NCSCH and Victorian Cancer Registry

The Study Roll, the NDI and the NCSCH files were standardised, as above, to improve the likelihood of successfully matching veterans' details. As well as mortality information, matching to the NCSCH and Victorian Cancer Registry provided information on date of diagnosis of a cancer, implying that the veteran was alive at that time.

The matching with the Victorian cases of the NCSCH could not be done by the AIHW for privacy reasons, but the matching strategy used by the Victorian cancer registry closely resembled the strategy used for matching the other NCSCH cases.

Matching with the State and Territory RBDMs

It was considered likely that a significant proportion of the 'unknown' group (i.e. those veterans who were not found on any of the above mentioned databases) may have been missed because they had died during the period from 1963 (when the first veterans returned from Vietnam) to 1980, immediately prior to the establishment of the NDI. In order to capture these deaths, the 'unknown' group was matched against State and Territory death records for the period. Records from all States and Territories were accessed, except for the Northern Territory where the possible returns were deemed too low. New South Wales, Victorian, Australian Capital Territory and Tasmanian records were matched in part by electronic means. All other records were matched manually. In some circumstances this meant searching nearly 20 yearbooks for approximately 4,500 names.

The data quality of the Registries' mortality information varies between States and Territories and over time within each State and Territory. Varying storage and indexing methods also influence the results of the data matching carried out for this study. Personnel carrying out the matching were provided with guidelines and encouraged to include doubtful matches that could then be further examined by AIHW to maximise consistency across States and Territories. The relatively conservative matching criteria adopted for the NDI and NCSCH matching were then applied to the State and Territory RBDMs.

4.3.3 Matching by the HIC

The HIC was responsible for the following tasks:

- matching of veterans whose vital status was previously unknown (i.e. there had been no match with the DVA Client Data Base, NDI or electoral roll) with their Medicare enrolment database record; and then
- retrieving the date of the most recent claim from the claim database.

For matching with the Medicare enrolment database, an exact match of surname, given names and the day, month and year of birth was used. Each matched record was linked to the claim database to determine the date on which the subject last received a medical service. That is, the date they were last known alive, unless a more recent date of death or departure from Australia, was recorded.

4.3.4 Other matching

Those study participants not identified through other sources were matched against databases from DIMIA and the Directorate of Honours and Awards. For matching with the Movement Reconstruction database maintained by DIMIA, an exact match of surname, given names and date of birth was used. A match indicated the last movement date in or out of Australia and thus the last known date alive.

The database maintained by the Directorate of Honours and Awards includes the service number of the veteran as a unique identifier. This database was useful in identifying changes of names since Vietnam service and alternative dates of birth for those study participants not identified on other databases.

4.4 Results of the matching process

The summary results of matching are presented in Table 4-4. It shows that vital status was determined for 97.3% of the cohort and 2.7% were lost to follow-up. Of the 2.7% lost to follow-up, 541 or 0.9% were partially unknown, that is, they were known to be alive until a specific time point during the study period but were lost to follow-up by the end of the study on 31 December 2001.

Table 4-4: Summary results of matching

Service branch	Alive		Dead		Unknown		Total
Navy	11,602	85.7%	1,491	11.0%	445	3.3%	13,538
Army	35,876	87.3%	4,180	10.2%	1,028	2.5%	41,084
Air Force	3,754	82.1%	711	15.6%	105	2.3%	4,570
All personnel	51,219	86.5%	6,382	10.8%	1,578	2.7%	59,179

Note: Column and row percentages may not add up to 100% due to rounding.
Personnel totals are less than the sum of the Service branches due to 13 servicemen having served in two branches.
Some deaths identified occurred after the end of the study period and were excluded from the analysis.

In this study, the Air Force and the Army had the lowest proportion of subjects lost to follow-up (2.3% and 2.5% respectively). The figure was higher for the Navy at 3.3%.

The Air Force had the highest proportion of subjects determined as being dead (15.6%). For the Navy, 11.0% were determined as being dead. The Army had the

lowest proportion of veterans who had died (10.2%). The Air Force personnel were on average older than the Navy and Army personnel; their median birth year was 1941 compared to 1946 for the Navy and Army personnel, as described in the following chapter.

4.5 Summary and discussion of determination of vital status

The prime objective of the matching was to determine the vital status of as many members of the cohort as possible. To achieve this, the study used a variety of sources of vital status data. Some of these are specific to Vietnam veterans while others are general to the whole Australian population.

The cohort was first matched with data held by DVA. This included data on deaths obtained from the Department of Defence and data on deaths and those alive, obtained from the DVA Client Data Base. These sources were not mutually exclusive. Some deaths that occurred before 1980 (including deaths during service) were identified from these sources.

All members of the cohort were then matched with the NDI to identify deaths in the period 1980–2003 not previously known to the DVA. The whole cohort was concurrently matched with the electoral roll to identify those who were alive. The statutory requirements that underpin compulsory registration on the electoral roll and the NDI are indicative of each database's completeness for Australia as a whole.

The names of those veterans who failed to match any of the above-mentioned sources were then matched with the Medicare database, NCSCH database, immigration records and pre 1980 deaths held at the State and Territory RBDMs.

Overall, 86.5% of the cohort was determined to be alive and 10.8% were accepted as having died. This left 2.7% of the veteran cohort for whom vital status remained unknown at the end of the study period.

The 1,578 veterans with an unknown vital status were not in contact with DVA after 31 December 2001, and were not found on the Australian Electoral Roll, the NDI or other databases accessed. For these veterans, it was therefore not possible to determine whether they were still alive and residing in Australia on 31 December 2001 or if they had died or moved permanently overseas. This group is referred to as the ‘veterans whose vital status is unknown’ or ‘veterans lost to follow-up’ for the purpose of this study. However, some of these unknowns were found on databases with entries prior to 31 December 2001, indicating that they were alive for at least some time of the study period.

4.5.1 Potential reasons for unknown status

The group of 1,578 veterans lost to follow-up will possibly contain subjects who died, most likely before 1 January 1980, the first date for data in the NDI, and

who were not captured by any of the DVA registers or the manual searches by the various RBDMs. Another proportion of the lost to follow-up may have emigrated from Australia since the end of the Vietnam War. Other reasons for lost to follow-up include:

- change of name since the end of the Vietnam War;
- living in certain types of institutional care;
- living in Australia but have never been or are no longer on the electoral roll; and
- typographical or other errors in data records in the Study Roll and/or databases used as sources of vital status information.

In summary, from a total cohort of 59,179 male Vietnam veterans followed up after approximately 30–40 years, the vital status of 2.7% remained unknown.

4.6 Statistical methods

4.6.1 Population at risk

Vietnam veterans became part of the population at risk when they returned from Vietnam. They contributed person-time until the study end date (31 December 2001) or the date they died, if this occurred during the study period. For example, a 23-year-old soldier departing Vietnam in 1972 and dying in 1993 aged 44 would contribute 21 person years to the population at risk.

The length of time each cohort member was alive during the period of observation from the time he returned from Vietnam until to 31 December 2001 was estimated and the person-years method was used to calculate the total number of person years at risk for each calendar year and five-year age group.

The size of the unknown vital status group (n = 1,578) was too large to ignore and therefore needed to be accounted for in the analysis. This was managed by treating the unknown vital status of veterans using two scenarios for the population at risk:

- Scenario 1 excludes veterans whose status is unknown from the at-risk population. These veterans are effectively treated as average compared to the other veterans. If the mortality rate of those lost to follow-up is substantially different, then the SMR using this scenario may be an over or under-estimate of the true situation.
- Scenario 2 includes veterans whose status is unknown in the at-risk population, and assumes that they are still alive and residing in Australia at the end of the follow-up on 31 December 2001. The effect of including veterans whose status is unknown is that the expected number of deaths may be over-estimated and thus the estimate of the SMR is lower than the ‘true’ situation. This is because the veteran

population under Scenario 2 is not adjusted for the possible death or emigration from Australia of those lost to follow-up.

In presenting the findings from the analysis in this report, both population scenarios are presented in the tables in Appendix D.

4.6.2 Causes of death amongst veterans

The identification of the cause of death (COD) amongst veterans was determined by matching the Study Roll against the deaths registrations at the Registries of Births, Deaths and Marriages (RBDM). This was achieved by matching with the National Death Index (NDI), which holds all RBDM deaths from 1980, or by directly searching pre 1980 deaths at the individual registries. This identified all causes of death registered between 1963 and 2001.

The expected number of deaths for selected causes of death groupings was calculated for each year by applying five-year age mortality rates for the selected disease groupings for the Australian male population to the corresponding age-specific number of living Vietnam War veterans in each year.

The steps involved in these calculations were:

- Calculate mortality rates for the Australian male population for each COD being studied, by five-year age groups, for each year from 1963 to 2001.
- Derive the population of living Vietnam War veterans (population at risk) by 5-year age groups from 1963 to 2001, from the Study Roll of Vietnam War veterans.
- Calculate the expected number of deaths of the COD being studied, had veterans experienced the mortality rates of the general Australian population for each year 1963 to 2001. This was done by multiplying the age-specific mortality rates for the Australian population by the corresponding veteran population by five-year age groups, of that year.
- Sum the yearly expected number of cases to derive the expected number of deaths for the 1963 to 2001 study period.

Australian age-specific mortality rates for some CODs were not available for the whole study period. In these instances, study periods were reduced by advancing the starting year to when Australian mortality rates became available.

4.6.3 Missing causes of death

One hundred and forty-four veterans (2.3% of all veteran deaths) were known to have died but their cause of death was not recorded. This had no bearing on the all causes analysis, but posed a problem for the cause-specific analysis. As there was no indication that these deaths were in any way different from known causes, they were assigned a cause of death according to the distribution of known causes, adjusting for the year of death.

4.6.4 Mortality analysis

The actual number of deaths experienced by the veteran population (observed cases) was compared to the expected number, by dividing the former figure by the latter. The resulting ratio, the standardised mortality ratio (SMR), is above one if the number of observed deaths among veterans is higher than the expected number. The ratio is below one if the number of observed deaths among veterans is lower than the expected number. On its own, the SMR is not sufficient to say whether the veterans experienced significantly higher or lower rates of mortality than might be expected because differences may arise by chance. The SMR is the best estimate of the difference between the veteran and the Australian population and the 95% confidence interval (CI) around the SMR gives an indication of the precision of that estimate. A narrow 95% CI indicates good precision, the true SMR is likely to lie within a narrow range of values, while a wide 95% CI indicates poor precision.

A SMR of 1.0 indicates that there is no difference in mortality between the Vietnam War veterans and the Australian community. A 95% CI which does not include the value 1.0 indicates that the calculated SMR is significantly different from 1.0 and, therefore, unlikely to be due to chance. In other words, there may be a real difference between the veterans and the Australian population. For example, a SMR of 1.22 with a CI of 1.1 to 1.4 is statistically significant because the interval does not include 1.0. If the CI were 0.9 to 1.5, the difference would not be statistically significant because the CI includes 1.0. Confidence intervals were calculated using the asymptotic method, except where the number of deaths was small (< = 20), when the exact method[7] was used.

The SMR and the CI are usually tabulated but sometimes visually displayed in figures in this publication (see for example Figure 6.1). These figures have a vertical line showing the location of a SMR of 1.0 indicating no difference in mortality. Horizontal lines for individual COD consist of a central dot showing the SMR for the COD and a horizontal error bar showing the 95% CI. Small error bars indicate good precision. The number of observed deaths is significantly different from the norm if the error bar does not cross the 1.0 line. Error bars which are wholly to the right of the vertical line indicate COD that are significantly more common than expected and those wholly to the left of the vertical line indicate COD that are significantly less common than expected.

4.7 Statistical power

In addition to SMRs and 95% CIs, a third factor, statistical power, is important in assessing the results of a study. The power of a study is the probability that the study will detect a statistically significant difference between two study groups if the groups truly differ. This probability depends on the size of the effect, the incidence of the outcome and the number of observations or participants in the study. If a cause of death is rare then even a large study may not have sufficient power to detect a true difference, especially if this difference is small. Conversely, if a COD is very common or the difference between the groups is

very large, then a smaller study will be able to detect a statistically significant result.

Table 4-5 shows the calculations for the estimated power of this study in assessing differences in mortality for the Vietnam veteran cohort compared to the Australian population. This reveals that the standardised mortality rate must exceed 10 per 100,000 per year for the study to have an 85% chance of detecting a 20% increase in relative risk (i.e. an SMR of 1.2) at the 0.05 level of significance.

For smaller groups, such as individual Service branches, the power to detect a significant result is lower. For example, for the Navy cohort of approximately 13,500 (See Chapter 5), the standardised mortality rate must exceed 45 per 100,000 per year for the study to have an 85% chance of detecting a 20% increase in relative risk at the 0.05 level of significance. For a similar level of power among Air Force veterans (approximately 4,500), the standardised mortality rate would need to exceed 130 per 100,000 per year.

Table 4-5: Estimated Power of the Mortality in Vietnam Veterans Study

Disease (ICD-10)	Standardised Death Rate (ABS 2000)	% Probability of detecting a significant difference in mortality of a given COD											
		Standardised Mortality Ratio (Ratio of change mortality in study population)											
		1	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**2**	**2.2**	**2.4**
All neoplasms (C00-D48)	216.0	5.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Malignant neoplasms (C00-C97)	212.0	5.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Head and neck	5.3	5.0	26.1	62.5	89.2	98.3	99.8	100.0	100.0	100.0	100.0	100.0	100.0
Colon (C18)	18.0	5.0	58.4	97.6	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Liver (C22)	5.3	5.0	26.1	62.5	89.2	98.3	99.8	100.0	100.0	100.0	100.0	100.0	100.0
Melanoma (C43)	7.3	5.0	32.1	74.6	95.9	99.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Brain (C71)	7.0	5.0	31.2	73.0	95.2	99.6	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Prostate (C61)	35.9	5.0	83.8	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Trachea, bronchus and lung (C33, C34)	54.8	5.0	94.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Hodgkin's disease (C81)	0.4	5.0	8.5	13.4	19.7	27.0	35.2	43.8	52.3	60.5	74.7	85.0	91.8
Non-Hodgkin's lymphoma (C82-85, C96)	10.4	5.0	40.7	86.6	99.2	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Lymphoid leukaemia (C91)	3.1	5.0	19.0	44.3	71.2	89.1	97.0	99.4	99.9	100.0	100.0	100.0	100.0
Diseases of circulatory system (I00-I99)	256.0	5.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Ischaemic heart disease	150.0	5.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Cerebrovascular disease (I60-I69)	54.0	5.0	94.4	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Diseases of respiratory system (J00-J99)	64.0	5.0	97.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Diseases of digestive system (K00-K93)	22.0	5.0	65.9	99.1	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Diabetes (E10-E14)	16.9	5.0	56.1	96.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Diseases of nervous system (G00-G99)	19.7	5.0	61.7	98.4	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
External causes (V01-Y98)	58.4	5.0	95.8	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
All causes	713.0	5.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[a] For males per 100,000 per year. Source: AIHW Mortality Database.

Notes: Shaded area indicates where study power less than 85 chance of detecting difference in mortality at the 0.05 level of significance

Assumptions:	Australian males	Number of individuals in comparison population	9,000,000
	Vietnam Veterans	Number of exposed participants in the study population	59,179
		Length of time of follow-up of the study population (years)	34
		All participants traced	

4.8 Statistical software used

Several statistical packages were used for data management and analysis. Initial processing, such as the calculation of person-years was performed in SAS[8] Release 8.2. Tables of observed and expected causes of death and the standardised mortality ratios were compiled in EXCEL[9] 2003 and DeltaGraph[10] Version 5.0.1 was used to produce the graphs.

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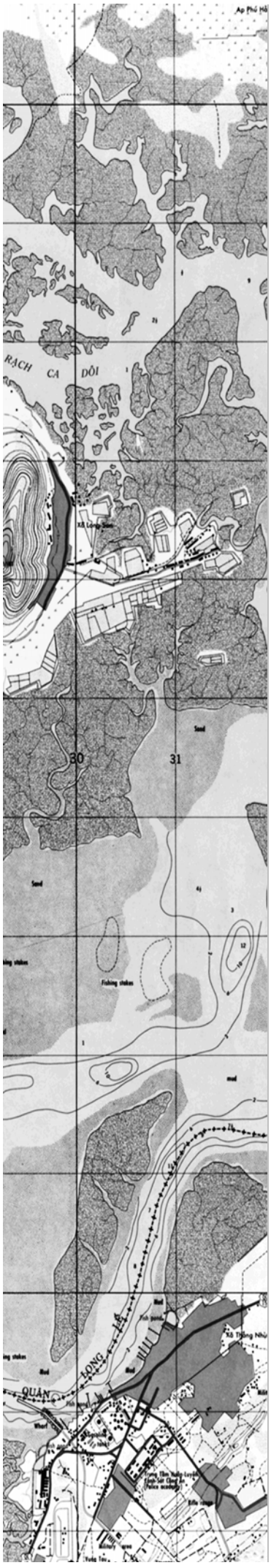


5

Characteristics of the male Vietnam veteran cohort

Chapter 5 Characteristics of the male Vietnam veteran cohort

This chapter describes the demographics and nature of service in Vietnam of the Australian male defence force Vietnam veterans.

5.1 Total number of veterans

Following the enhancement of the Nominal Roll of Vietnam Veterans as described in Chapter 3, the cohort of military Vietnam veterans comprised 59,179 male defence force veterans. Table 5-1 gives the numbers in the cohort by service branch. Thirteen veterans served in two Service branches; eight in the Navy and Army and five in the Air Force and Army.

Table 5-1: Number of male defence force Vietnam veterans

Service branch	Number	(%)
Navy	13,538	(22.9)
Army	41,084	(69.4)
Air Force	4,570	(7.7)
Total	**59,179** [a]	

[a] Thirteen veterans served in two services

5.2 Birth year and age of first service

The majority of Vietnam veterans were born during the 1940's but the range of birth years spanned from 1903 to 1956. Figure 5-1 shows the distribution of birth years for Vietnam veterans.

The average age at the start of Vietnam service for defence force personnel was 24 years. However, the mean age varied between the Service branches with Navy having the youngest average age at first service and Air Force personnel the oldest. Table 5-2 shows the age at first service for the cohort. Twenty-eight percent of Navy veterans were under 19 years of age when they first served in

Vietnam whereas only 0.2% of Army personnel and 1.6% of Air Force personnel were less than 19 years old when they first served in Vietnam.

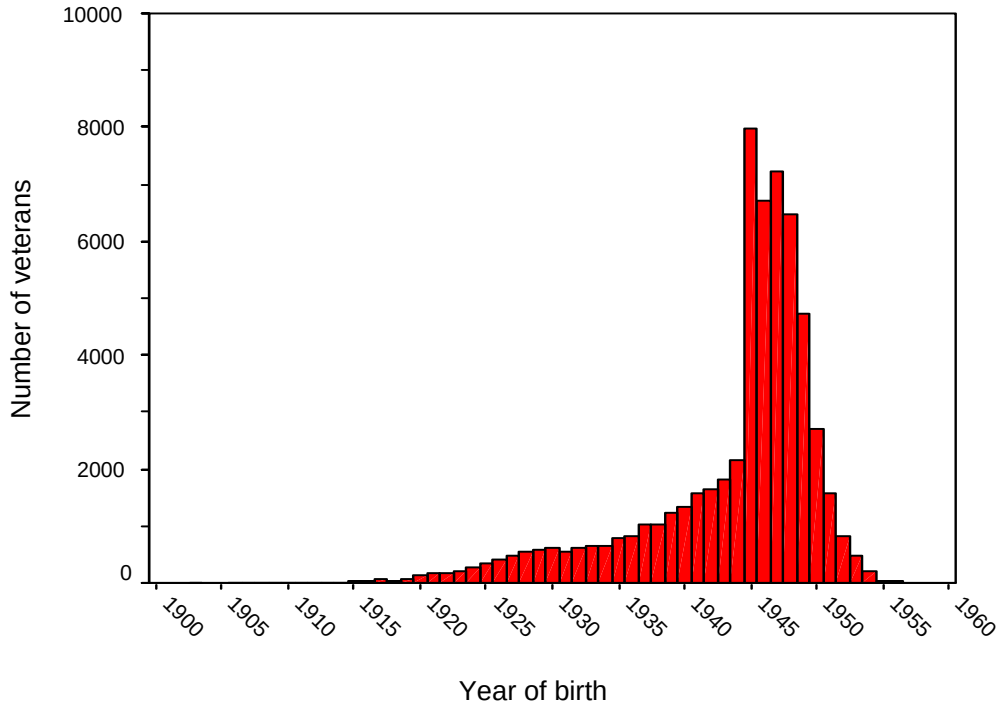


Figure 5-1: Number of Vietnam veterans by birth year

Table 5-2: Age at start of Vietnam service by Service branch

Service branch	Mean Age ± SD [a]	Range (years)	Median	90th Percentile
Navy	22.5 ± 6.3	16 – 59	20	32
Army	23.8 ± 5.9	17 – 64	21	33
Air Force	28.1 ± 7.7	17 – 55	26	40
Total	**23.9 ± 6.3**	**16 - 64**	**21**	**34**

[a] Information on age at the start of Vietnam service is missing for 61 veterans (59 Navy veterans and two Air Force veterans)

5.3 Nature of service

A number of measures of service in Vietnam were drawn from the veterans' service details and, in the case of Navy veterans, ships' logs. Duration of service was measured as total time of Vietnam service. In addition, for Navy personnel, time in Vietnamese waters was calculated. The characteristics of service were also measured by Service branch: the units and total number of units served, the number of tours and the year of service.

5.3.1 Time in Vietnam

Duration of Vietnam service was defined by the *VEA* dates. *VEA* dates determine those days for which a veteran served in the operational area of Vietnam as legislated by the Act in consultation with Defence. For the purposes of this study, Vietnam was considered an operational area for the period from 23 May 1962 through 1 July 1973. In 1997, service rendered in the operational area 'Vietnam (Southern Zone)' between 12 January 1973 and 29 April 1975 was also deemed as warlike service. For the purposes of this study, the concluding date of 1 July 1973 is maintained in line with the previous study.

In this period, Vietnam veterans overall served an average of 266 days in Vietnam with 90% of personnel serving 385 days or less. Figure 5-2 shows the distribution of total days of Vietnam service.

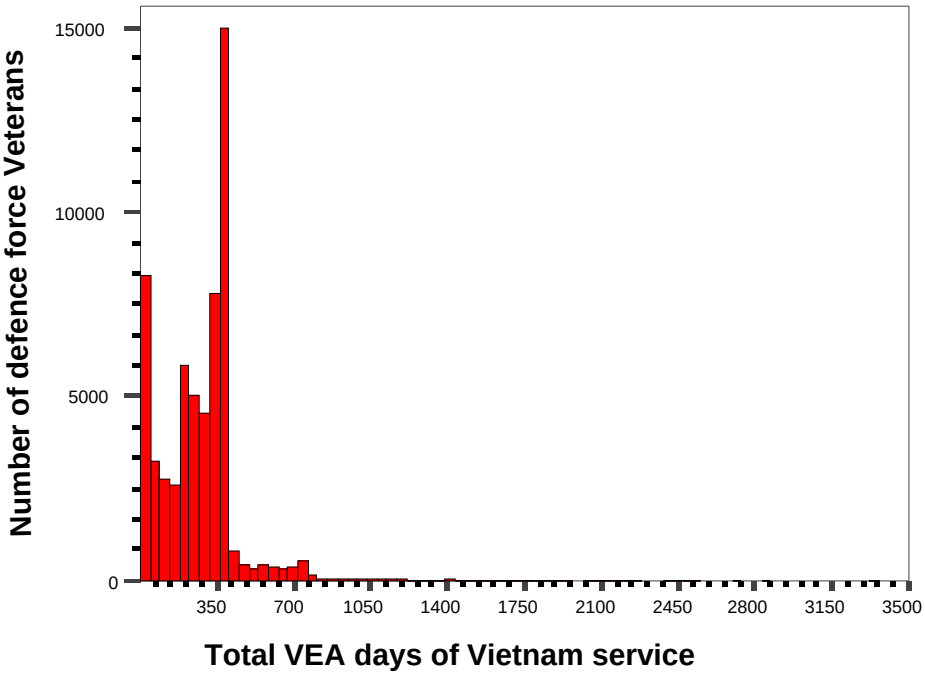


Figure 5-2: Duration of Vietnam service for defence force Vietnam veterans

A small proportion (1.5%) of veterans had lengthy service of more than two years. These 891 veterans served an average of 969 days with a maximum of nine years of service during this 10-year conflict. Three quarters of the long serving veterans served in the Army and the remainder served in the Air Force.

The average duration of service varied between the Service branches and is described in detail in the following sections.

Duration of Navy service

For the purposes of this study, the duration of Navy veterans' Vietnam service was defined by total VEA days and total days in Vietnamese waters. The definition of VEA days varies with the ship or unit served. For gunline ships, VEA coverage encompasses the date the ship departed from Australia to the date the ship arrived back in Australia. For those ships categorised as troop, logistic, escort or cargo, or for individuals, VEA coverage was the date of the last port of call prior to entering the Vietnam operational area to the date arriving at the first port of call after leaving the Vietnam operational area. The Vietnamese water dates are the dates the ship or individual was in the Vietnam operational area defined as 185.2 km from the Vietnamese coast. Vietnamese water dates were obtained from ship logs for all gunline voyages and pre-1970 voyages for troop and escort ships. Vietnamese water dates for post-1970 voyages for troop and escort ships were obtained from published histories and ship logs.

The average number of VEA days for Navy personnel was 99 days whereas the average number of Vietnamese water days was 34 days as detailed in Table 5–3. The characteristics of the types of Navy service which contribute to the difference in VEA days and Vietnamese water days is described in Section 5.3.2: Types of service.

Table 5-3: Duration of service in Vietnam by Service branch

Days of service	Mean Days ± SD [a]	Median	Range (days)	75th Percentile (days)
Navy				
VEA days	99.1 ± 109.4	46	1 – 764	164
Vietnamese water days	34.3 ± 66.3	5	1 – 764	14
Army				
VEA days	311.5 ± 137.3	339	1 – 2120	367
Air Force				
VEA days	350.7 ± 285.8	359	1 – 3321	367

[a] Information on duration of service is missing for 61 Navy veterans and three Air Force veterans.

Figures 5-3 and 5-4 show the distribution of days in Vietnam as defined by VEA days and Vietnamese water days for Navy veterans.

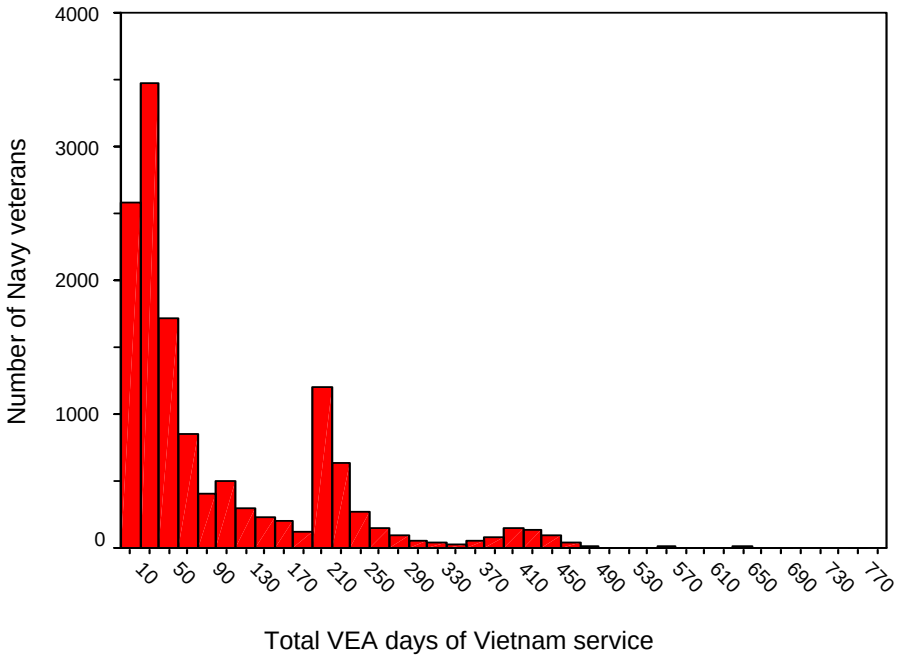


Figure 5-3: Total number of VEA days of Vietnam service for Navy veterans

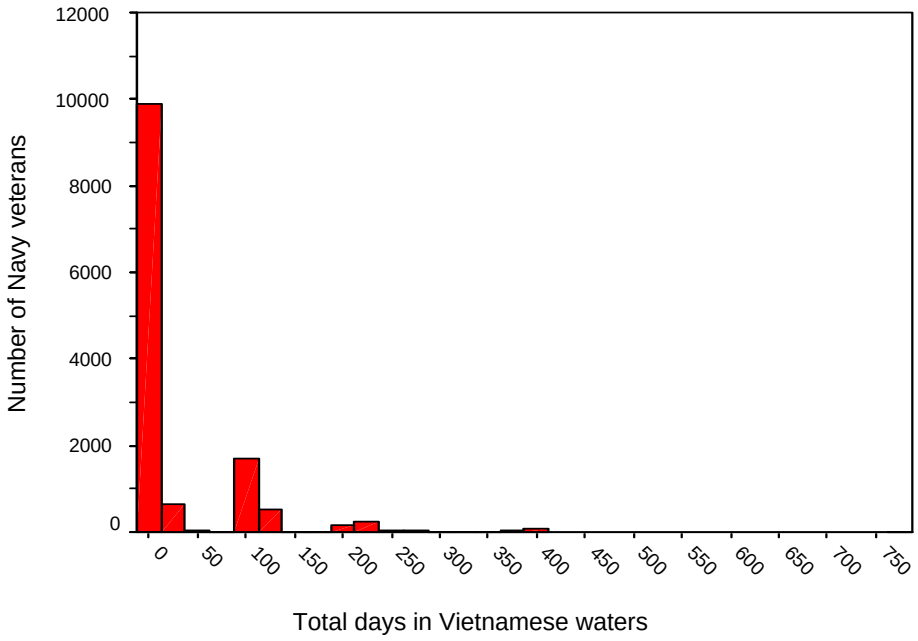


Figure 5-4: Total number of days in Vietnamese waters for Navy veterans

Duration of Army service

The Army cohort of 41,084 personnel spent an average of 311 days in Vietnamese service (Table 5-3).

Figure 5-5 shows the distribution of days of Army service in Vietnam. The majority (75%) of Army veterans served up to one year with only a minority (25%) serving more than one year.

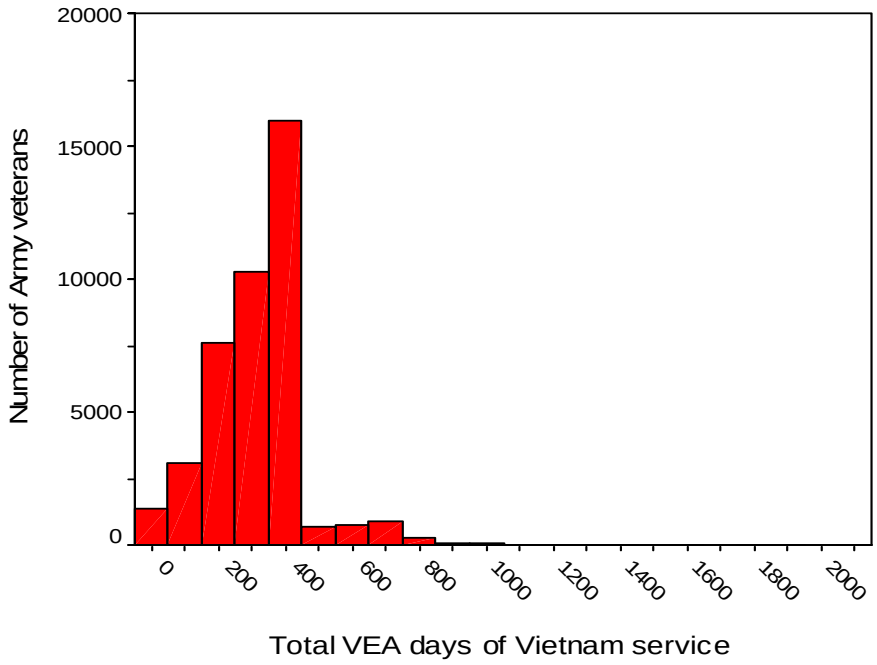


Figure 5-5: Total number of VEA days for all Army veterans

Duration of Air Force service

Air Force personnel averaged 351 days service in Vietnam (Table 5-3). As with the Army veterans, the largest proportion of Air Force veterans completed approximately one year of service (Figure 5-7). Two percent of Air Force personnel had extremely long service of four years or more. However this may be an artefact of incomplete service details. As discussed in Chapter 3, service details for Air Force may not accurately reflect time in Vietnam and may instead record the departure date of their first flight to Vietnam and the return date of their last flight from Vietnam.

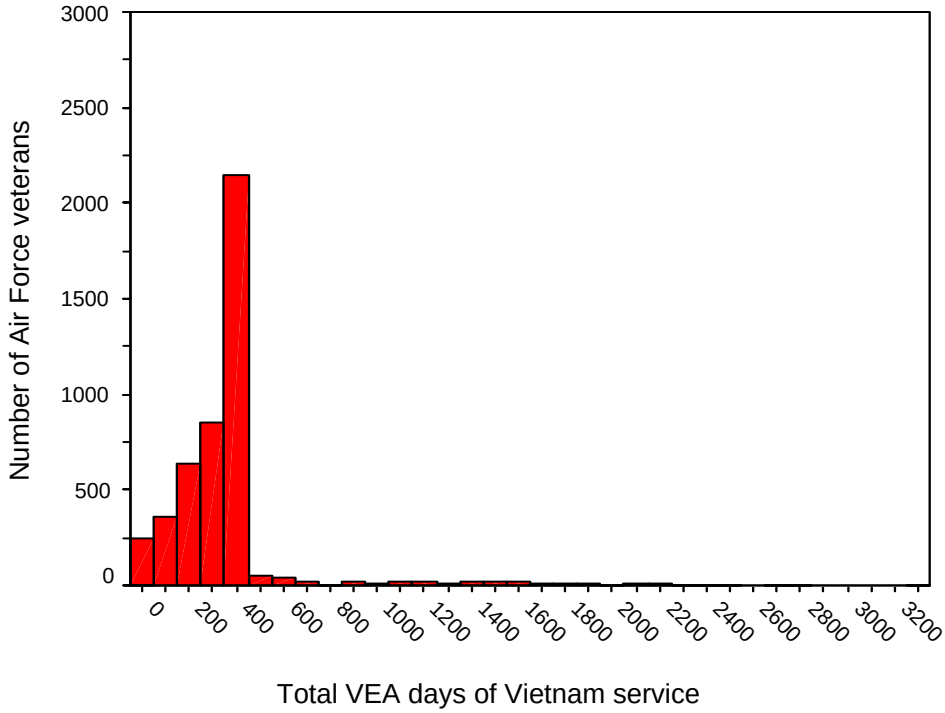


Figure 5-6: Total number of VEA days for Air Force veterans

5.3.2 Type of service

The information on the Australian Vietnam defence force veterans' service encompassed 111,020 lines of data for the 59,179 individuals. Vietnam veterans served in an average of 1.3 units for an average of 1.7 tours with a maximum of six units and 25 tours. (Table 5-4) For the purposes of this study, a tour is broadly defined as a single period of allotted service in Vietnam, and does not differentiate regarding length of time spent in Vietnam.

Table 5-4: Number of units and tours served in Vietnam by Service branch

Characteristic	Mean ± SD	Median	Range	90th Percentile
All veterans				
Number of units	1.3 ± 0.6	1	1–6	2
Number of tours	1.7 ± 1.3	1	1–25	3
Navy				
Number of units	1.3 ± 0.6	1	1–6	2
Number of tours	2.6 ± 2.1	2	1–25	5
Number trips in & out of Vietnam	3.5 ± 2.9	2	1–25	7
Army				
Number of units	1.3 ± 0.6	1	1–6	2
Number of tours	1.4 ± 0.8	1	1–17	2
Air Force				
Number of units	1.1 ± 0.4	1	1–5	2
Number of tours	1.2 ± 0.7	1	1–20	2

Navy service

The 13,538 Navy veterans served on 19 ships, which completed 110 voyages in the Vietnam era. Navy personnel also served in in-country units such as Clearance Diving Team 3 or 1 Australian Field Hospital. With the exception of two diplomatic voyages in 1963, naval involvement in Vietnam did not begin until 1965.

The nature of naval service varied depending on the unit or ship. In general, gunline ships were assigned to the operational area for five to six months. This tour consisted of four to six blocks of time in which approximately three to four weeks were spent in the operational area along the coast followed by a week to ten days outside the operational area at a non-Australian port. The gunline ships were: HMAS *Brisbane*, HMAS *Hobart*, HMAS *Perth* and for one voyage HMAS *Vendetta*. The troop, logistic, escort or cargo ships were generally in Vietnamese waters for one to three days per tour and spent the rest of their time between other Southeast Asian or Australian waters and ports. In-country units were land based and generally averaged longer tours (approximately one year) than the ship units. Table 5-5 shows the distribution of service in the Navy units.

Table 5-5: Navy units served during Vietnam

Unit	Number served [a]	Percent
Gunline		
HMAS *Brisbane*	649	3.6
HMAS *Hobart*	906	5.0
HMAS *Perth*	849	4.7
Troop Transport		
HMAS *Sydney*	5,735	31.6
Escort		
HMAS *Anzac*	272	1.5
HMAS *Derwent*	755	4.2
HMAS *Duchess*	1,182	6.5
HMAS *Melbourne*	2,139	11.8
HMAS *Parramatta*	732	4.0
HMAS *Queenborough*	146	0.8
HMAS *Quiberon*	148	0.8
HMAS *Stuart*	339	1.9
HMAS *Swan*	260	1.4
HMAS *Torrens*	253	1.4
HMAS *Vampire*	1,325	7.3
HMAS *Vendetta* [b]	1,031	5.7
HMAS *Yarra*	857	4.7
Cargo		
HMAS *Boonaroo*	38	0.2
MV *Jeparit* [c]	71	0.4
HMAS *Jeparit*	82	0.5
In-country		
HQ	10	0.1
Band	20	0.1
CDT3	48	0.3
No 9 SQN RAAF	7	0.0
Helicopter Flight Vietnam	191	1.1
1 AUST FD Hosp	10	0.1
Navy Visit [d]	81	0.4
Total	**18,136**	**100.0**

[a] Naval personnel may have more than one entry
[b] HMAS *Vendetta* served one voyage as a gunline ship and three voyages as an escort ship
[c] MV Jeparit first served as a merchant vessel with combined RAN and merchant crew
[d] Official Navy visits could be either on-board ships or in-country

The majority (71%) of Navy veterans served in one unit or ship but 62% of the cohort did multiple tours to Vietnam. In this study Navy service is also characterised by number of trips in and out of Vietnamese waters. Gunline ships had four to six trips per tour, whereas troop and escort ships had one trip per tour.

Two hundred and eighty-six men served in Navy in-country units. Of these veterans, half served in one unit only and the group averaged service in 1.6 units (range 1–4) and completed an average of 2.1 tours (range 1–7).

Army service

The Army had the largest contingent in Vietnam with 41,084 personnel serving in nearly 200 different units. Table 5-6 details the units in which more than 800 personnel served. The number listed as having served in the Royal Australian Regiment (RAR) may be an underestimate of the true number, as service details on the roll do not always include all postings or detachments. Those listed in 1 Australian Reinforcement Unit, were in fact in this unit for a short time and may have gone on to serve in one of the battalions or other units.

Table 5-6: Army units in which greater than 800 personnel served during Vietnam

Army Unit	Number of personnel [a]	Percentage
A Squadron 3 Cavalry Regiment	850	1.6
Australian Army Training Team Vietnam	959	1.8
Headquarters Australian Force Vietnam	1,517	2.8
Headquarters 1 Australian Logistics Support Group	847	1.6
Headquarters 1 Australian Task Force	1,398	2.6
1 Field Regiment	1,040	1.9
4 Field Regiment	1,014	1.9
12 Field Regiment	933	1.7
1 Field Squadron	1,563	2.9
104 Signals Squadron	824	1.5
110 Signals Squadron	1,239	2.3
17 Construction Squadron	1,919	3.6
2 Advanced Ordnance Depot	1,070	2.0
1 Australian Reinforcement Unit	4,426	8.2
1 Battalion, Royal Australian Regiment	2,062	3.8
2 Battalion, Royal Australian Regiment	2,020	3.7
3 Battalion, Royal Australian Regiment	1,984	3.7
4 Battalion, Royal Australian Regiment	1,682	3.1
5 Battalion, Royal Australian Regiment	2,114	3.9
6 Battalion, Royal Australian Regiment	1,890	3.5
7 Battalion, Royal Australian Regiment	2,278	4.2
8 Battalion, Royal Australian Regiment	1,127	2.1
9 Battalion, Royal Australian Regiment	1,223	2.3
All other units	17,919	33.2
Total	**53,898**	**100.0**

[a] Army personnel may have more than one entry

Air Force service

The Air Force units allotted to Vietnam service were stationed both in Vietnam and outside Vietnam territory. Table 5-8 shows the number of personnel serving in the Air Force units by their location.

Table 5-7: Air Force units serving during Vietnam

Air Force Unit	Based in Vietnam	Based outside Vietnam	Number served [a]	Per cent
Band	X		53	1.0
Clark Air Force Base		X	2	0.0
Headquarters Australian Force Vietnam	X		298	5.8
Headquarters RAAF Vung Tau	X		67	1.3
No 5 Airfield Construction Squadron	X		108	2.1
Medevac Flight		X	1	0.0
US Air Force	X		3	0.1
No 1 Operational Support Unit	X		595	11.5
Support Flight/1 Operational Support Unit	X		474	9.2
Air Force visit		X	27	0.5
161 Reconnaissance Flight, Australian Army [b]	X		32	0.6
No 3 Hospital		X	12	0.2
No 4 Hospital		X	29	0.6
No 2 Squadron	X		1,435	27.7
No 9 Squadron	X		886	17.1
No 10 Squadron		X	4	0.1
No 11 Squadron		X	1	0.0
No 35 Squadron	X		622	12.0
No 36 Squadron		X	159	3.1
No 37 Squadron		X	83	1.6
Transport Flight/No 35 Squadron	X		268	5.2
902 Aeromedical Evacuation Squadron, USAF	X	X	11	0.2
903 Aeromedical Evacuation Squadron, USAF	X	X	1	0.0
Transport Support Flight Butterworth		X	2	0.0
Total			**5,173**	**100.0**

[a] Air Force personnel may have more than one entry.
[b] Air Force specialists were among this army aviation unit.

5.4 Involvement in other deployments

The Vietnam veteran study roll was matched against the other nominal rolls managed by DVA (the Nominal Roll of Australian Veterans of the Korean War and the World War II Nominal Roll) to determine the number of Vietnam veterans that participated in these other military operations. This was done due to the consideration that Vietnam veteran involvement in other deployments might influence health outcomes. A total of 1,993 Vietnam veterans, approximately 3%, have been identified as serving in one or more of the above deployments. Table 5-9 details the number of Vietnam veterans serving in World War II or the Korea War or both of these specific deployments.

Table 5-8: Number of Vietnam veterans who served in other pre-1973 deployments

Nominal Roll	Service branch			Total (% of cohort)
	Navy (% of branch)	Army (% of branch)	Air Force (% of branch)	
One other operation				
WWII	82 (0.6%)	419 (1.0%)	125 (2.7%)	626 (1.1%)
Korea	268 (2.0%)	788 (1.9%)	53 (1.2%)	1,109 (1.9%)
Multiple other operations				
WWII & Korea	72 (0.5%)	160 (0.4%)	26 (0.6%)	258 (0.4%)
Total	**422 (3.1%)**	**1367 (3.3%)**	**204 (4.5%)**	**1,993 (3.4%)**

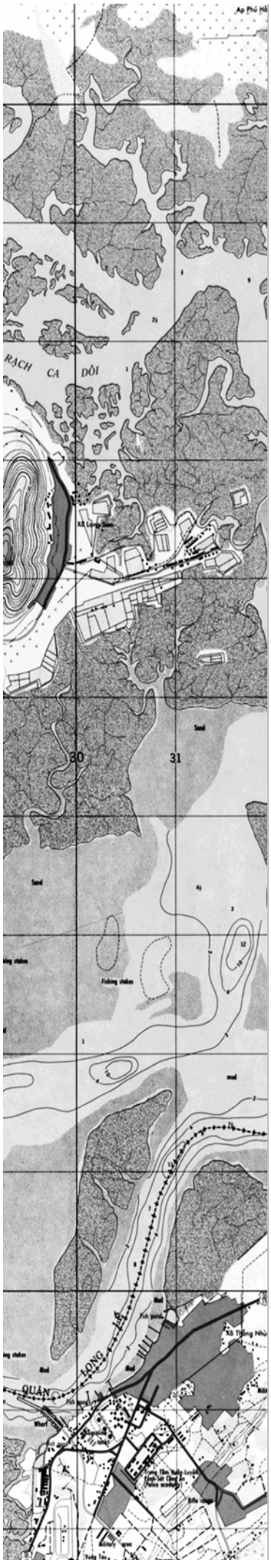
5.5 Summary

The nature of service varied considerably between the Service branches. Army and Air Force service averaged approximately one year of service in Vietnam whereas Navy service averaged approximately three months. The Navy cohort was substantially younger than Army or Air Force personnel when they first served in Vietnam with 28% of Navy veterans less than 19 years of age at the time of first entering Vietnam.

Seventy-five percent of Vietnam veterans served in only one unit and 65% completed only one tour but this also varied by Service branch. Seventy-one percent of Navy veterans served in only one unit or ship but multiple tours were more common with only 38% completing one tour. Seventy-four percent of Army veterans served in one unit only and 68% completed only one tour. The comparable figures for Air Force veterans were 88% and 86%.

The DVA has compiled nominal rolls for three military deployments or operations from World War II through Vietnam. Matching the Vietnam veteran study roll to these nominal rolls show that 3.4% of the study's veteran cohort had service in one or more of these other military services.

Although the Nominal Roll of Vietnam Veterans has been extensively updated, inaccuracies still exist in the service details. Thus the characteristics of service and completeness of service details need to be considered when interpreting the results.



6

Results

Chapter 6 Results

This chapter presents the results of the mortality analysis. It describes veteran mortality for broad disease groups of the International Classification of Diseases (ICD) and specific diseases of interest within some of the groupings. Mortality by branch of Service is also reviewed.

6.1 Overview of analysis

This study investigated the mortality of the Vietnam veterans from the time of completion of their first Vietnam service to 31 December 2001. Results are presented as standardised mortality ratios (SMR). The SMR is the ratio of observed deaths among Vietnam veterans to the expected number of deaths among male Australians of the same age in the same time period.

As described in Chapter 4, due to the uncertainty of the vital status of the 2.7% of veterans lost to follow-up, the SMR results are presented using two scenarios for the population at risk:

- Scenario 1 excludes veterans whose status is unknown from the at-risk population. These veterans are effectively treated as average compared to the other veterans, which may or may not be true. If the mortality rate of those lost to follow-up is substantially different from those whose fate is known, then the SMR using this scenario would be an over or under-estimate of the true situation.
- Scenario 2 includes veterans whose status is unknown to the at-risk population, and assumes that they are still alive and residing in Australia at the end of the follow-up on 31 December 2001. The effect of including veterans whose status is unknown is that the expected number of deaths may be over-estimated. This is because the veteran population under Scenario 2 is not adjusted for their possible death or migration out of Australia.

Calculation of SMR by themselves is insufficient for determining whether veterans experienced significantly higher or lower mortality than might be expected. Calculation of the 95% CI is used to determine whether the higher or lower mortality experienced by veterans is statistically significantly different from what would be expected or whether the differences could be due to chance. A 95% CI that excludes 1.0 indicates the result is statistically significant.

By convention this statistical significance is at the 0.05 level, which means there is up to a one in twenty probability the result could be due to chance. Thus the concept of multiple comparisons should be considered. This report investigates over 60 specific causes of cancer and non-cancer mortality, which means that some results which the 95% CI indicate are statistically significant, by definition could have up to a one in twenty probability to be

due to chance. In the current situation where 60 tests are performed, three such cases would be expected to be due to chance.

As discussed in Chapter 4, issues of study power, as well as statistical significance, need to be considered when interpreting the results presented in this report. The size of the group being studied, the magnitude of the effect observed and the rate of occurrence of a cause of death influence statistical power.

Complete results are tabled in Appendix D. This chapter focuses on those results that show a statistically significant difference from the rates expected in the Australian population. As differences between the two analysis scenarios are minor, results from Scenario 1 only are presented in this chapter to enhance readability.

6.2 Mortality of Vietnam veterans

There were a total of 6,166 deaths among the 59,179 Vietnam veterans. The most frequent causes of death were neoplasms (2,058), circulatory diseases (1,767) and external causes of death such as suicide and motor vehicle accidents (1,394). These three mortality groups account for 85% of all deaths observed.

Overall mortality for military Vietnam veterans was 6% lower than expectation, SMR 0.94, (95% CI 0.92, 0.97). Table D1 in Appendix D shows the SMR and their confidence intervals for all causes and specific causes for the Vietnam veteran cohort for both Scenarios.

The SMR and 95% CI for all causes of death and 31 specific causes are shown in Figure 6-1. Specific causes were chosen because of *a priori* interest or because they are representative of the Australian community. Interpretation of these figures is described in Chapter 4, section 4.6.4.

There were no causes of death that were significantly more common than expected under either scenario except suicide by gas. Mortality from neoplasms and alcoholic liver disease was significantly elevated by 6% and 19%, respectively in Scenario 1 but not significantly in Scenario 2. Several causes of death were significantly lower than expected and are detailed in Table 6-1.

Notably mortality from diseases of the circulatory system and respiratory system, which are among the leading causes of death for this age group in the Australian population,[1] was significantly lower than expected.

The HIV pandemic did not result in increased mortality among Australian Vietnam veterans as compared to the general Australian community. There were 39 deaths observed in this population of Vietnam veterans, whereas based on the mortality in the Australian community of males of the same age and time there would have been 49 deaths expected.

Table 6-1: Standardised Mortality Ratios (SMR) for causes of death which were significantly lower than expected: all Vietnam veterans

Cause of Death	Number of deaths	SMR	95% CI
All causes	6,166	0.94	0.92, 0.97
Infectious diseases[a]	33	0.62	0.41, 0.83
Endocrine diseases	94	0.62	0.49, 0.74
Diabetes	55	0.52	0.38, 0.66
Mental and behavioural disorders	51	0.61	0.45, 0.78
Nervous system diseases	91	0.78	0.62, 0.94
Circulatory system diseases	1,767	0.88	0.84, 0.92
Ischaemic	1,297	0.94	0.89, 0.99
Stroke	223	0.80	0.70, 0.91
Respiratory system diseases	239	0.77	0.67, 0.87
COPD[b]	128	0.85	0.70, 1.00[c]
Digestive system - Peptic ulcers	12	0.55	0.27, 0.93
Genitourinary system diseases	30	0.66	0.42, 0.90
Congenital abnormalities	6	0.24	0.09, 0.52
External causes - Assault	31	0.56	0.36, 0.76

[a] excludes AIDS deaths

[b] Chronic obstructive pulmonary disease

[c] Borderline statistical significance

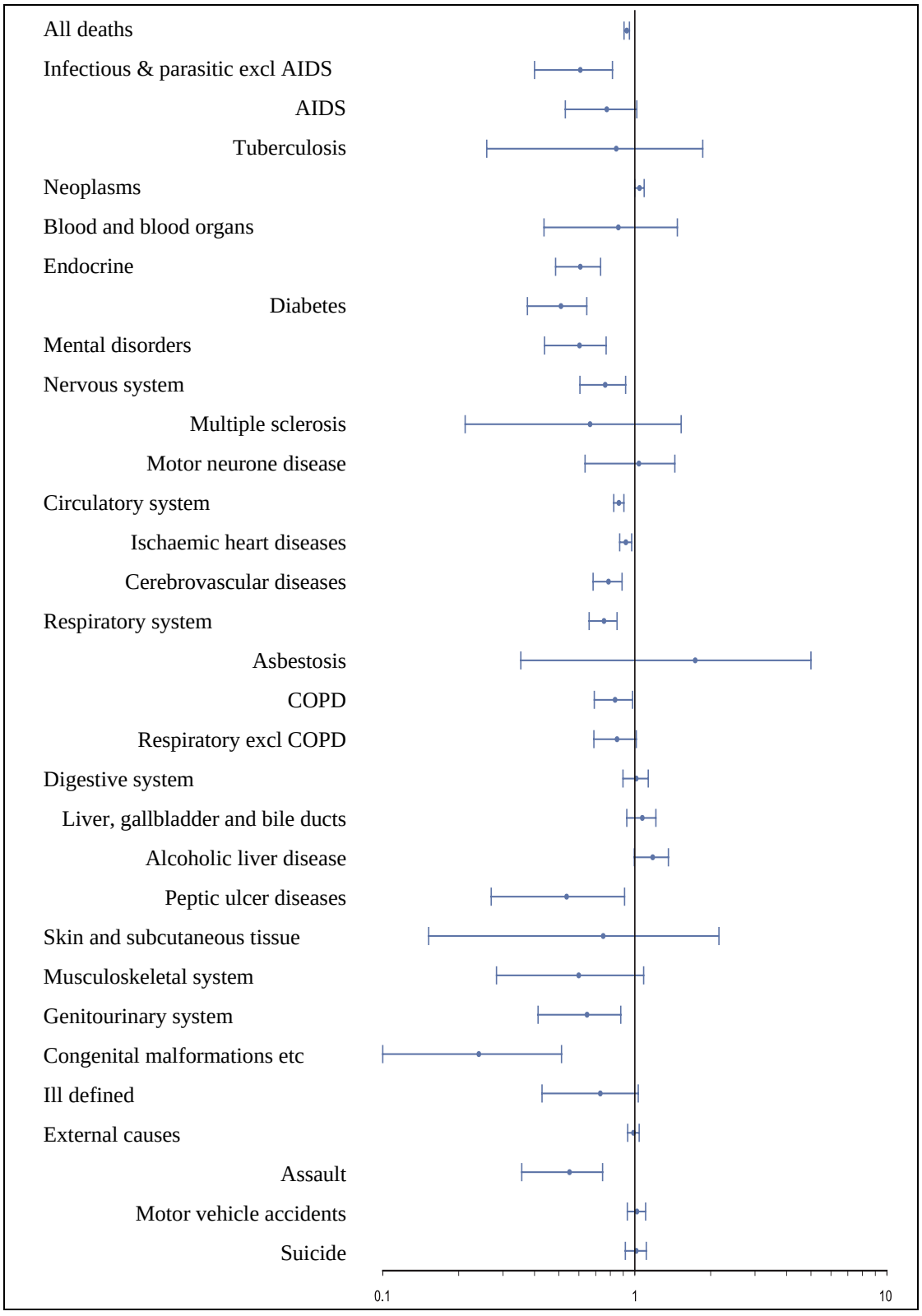


Figure 6-1: Standardised Mortality Ratios (SMRs) and 95% CIs for all Vietnam veterans

6.3 Deaths from diseases of *a priori* interest

In developing the protocol for this study, several causes of death were considered to be of particular interest due to results of previous studies, reviews of the literature or concerns of veteran organisations. These specific *a priori* causes of death are listed in the protocol in Appendix B. Minor changes have been made to the list of diseases to compensate for changes in coding practices and availability of data. Data for the infectious disease group excludes deaths from AIDS as coding for AIDS deaths had been allocated to different disease groups prior to the present standardisation. Also, cirrhosis of the liver was changed to alcoholic liver disease.

Table 6-2 provides the SMR for those diseases of *a priori* interest. Of the nine non-neoplastic causes of death, the mortality rates of three (infectious diseases, ischaemic heart disease, and neurological diseases) were significantly lower than the rates of the Australian population. Furthermore there was a decrease in COPD which was of borderline significance. The mortality rates from digestive disease, motor neurone disease, suicide and motor vehicle accidents did not differ from expectation. Significantly higher mortality from alcoholic liver disease was observed for Vietnam veterans in Scenario 1 only.

Mortality from cancer was 6% higher than expected. Mortality for individual cancer sites of *a priori* interest is discussed in Section 6.5.

Table 6-2: Standardised Mortality Ratios (SMR) for *a priori* causes of death for the Vietnam veteran cohort

Cause of Death	Number of deaths	SMR	95% CI
All causes	6,166	0.94	0.92, 0.97
Infectious diseases[a]	33	0.62	0.41, 0.83
Neoplasms	2,058	1.06	1.02, 1.11
Ischaemic heart disease	1,297	0.94	0.89, 0.99
Chronic obstructive pulmonary disease	128	0.85	0.70, 1.00
Digestive diseases	292	1.03	0.91, 1.15
Alcoholic liver disease	161	1.19	1.01-1.38
Neurological diseases	91	0.78	0.62, 0.94
Motor neurone disease	25	1.06	0.64, 1.47
Suicide	421	1.03	0.93, 1.13
Motor vehicle accidents	553	1.03	0.95, 1.12

[a] excludes AIDS deaths

6.4 Mortality by branch of Service

Mortality was investigated by branch of Service. Table 6-3 details the number of deaths and person years that contributed to the analysis by Service branch.

Table 6-3: Number of deaths and person years contributed by branch of Service

Service Branch	Number of veterans contributing to the analysis[a]	Number of unknowns	Number of deaths	Person Years contributed	
				Unknowns Excluded	Unknowns Included
Navy	13,538	445	1,435	435,387	446,199
Army	41,084	1,028	4,045	1,289,433	1,312,549
Air Force	4,570	105	686	138,999	141,331
Total	59,179	1,578	6,166	1,863,394	1,899,654

[a] Total is less than sum due to 13 servicemen having served in two branches.

6.4.1 Mortality of Navy Vietnam veterans

There were 1,435 deaths among the 13,538 Navy Vietnam veterans. The most common causes of death were from neoplasms (491), circulatory diseases (399) and external causes of death such as suicide and motor vehicle accidents (340), comprising 86% of all observed deaths.

Navy veterans had an overall mortality which was not significantly different from the Australian population, SMR 1.00, (95% CI 0.95, 1.06). The SMR and 95% CI for all causes of death and 31specific causes are shown in Figure 6-2.

Two causes of death analysed revealed higher than expected mortality rates: cancer and suicide by gas. Mortality from cancer among Navy veterans was 19% higher than expected, SMR 1.19, (95% CI 1.08, 1.29). Mortality from specific cancers types is discussed in Section 6.5.

Mortality from several causes of death was significantly lower than expected. These are listed in Table 6-4. Mortality from all other causes was not significantly different from expectation.

Complete results can be found in Table D2, Appendix D.

Table 6-4: Standardised Mortality Ratios (SMR) for causes of death which were significantly lower than expected: Navy Vietnam veterans

Cause of Death	Number of deaths	SMR	95% CI
Diabetes	12	0.54	0.28, 0.94
Mental and behavioural disorders	9	0.48	0.22, 0.89
Respiratory system diseases	50	0.76	0.55, 0.97

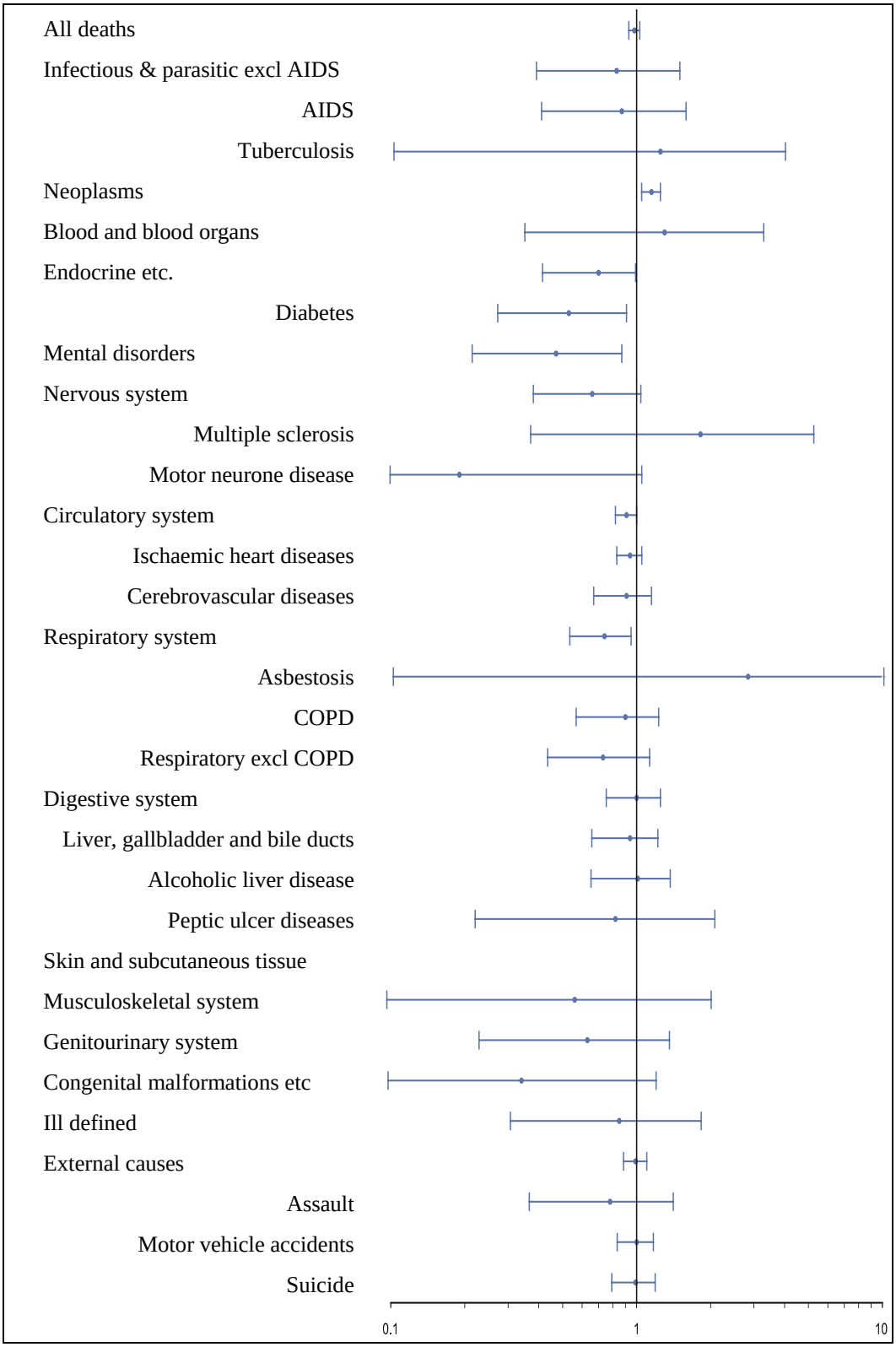


Figure 6-2: Standardised Mortality Ratios (SMRs) and 95% CIs for Navy Vietnam veterans

6.4.2 Mortality of Army Vietnam veterans

There were 4,045 deaths among the 41,084 Army Vietnam veterans. The most common causes of death were from neoplasms (1,323), circulatory diseases (1,136) and external causes of death such as suicide and motor vehicle accidents (954), comprising 84% of all observed deaths.

Army veterans had an overall mortality which was 7% lower than expected, SMR 0.93, (95% CI 0.90, 0.96). The SMR and 95% CI for all causes of death and 31 specific causes are shown in Figure 6-3.

None of the causes of mortality analysed showed a higher than expected mortality rate for Army veterans in both Scenarios. However, mortality from several causes of death was significantly lower than expected. These are listed in Table 6-5. Notably, mortality from respiratory diseases, circulatory diseases and specifically cerebrovascular disease or stroke was lower than expected. Mortality from all other causes was not significantly different from expectation.

Complete results can be found in Table D3 Appendix D.

Table 6-5: Standardised Mortality Ratios (SMR) for causes of death which were significantly lower than expected: Army Vietnam veterans

Cause of Death	Number of deaths	SMR	95% CI
All deaths	4,045	0.93	0.90, 0.96
Infectious diseases[a]	19	0.54	0.32, 0.83
Endocrine diseases	60	0.59	0.44, 0.74
Diabetes	37	0.52	0.35, 0.69
Mental and behavioural disorders	38	0.68	0.46, 0.89
Nervous system diseases	60	0.76	0.57, 0.95
Circulatory diseases	1,136	0.86	0.81, 0.91
Cerebrovascular	128	0.70	0.58, 0.83
Respiratory diseases	162	0.80	0.68, 0.92
Digestive diseases – Peptic ulcers	7	0.49	0.19, 0.98
Genitourinary diseases	18	0.62	0.36, 0.96
Congenital abnormalities	3	0.18	0.04, 0.51
External causes – Assault	20	0.53	0.30, 0.76

[a] excludes death from AIDS

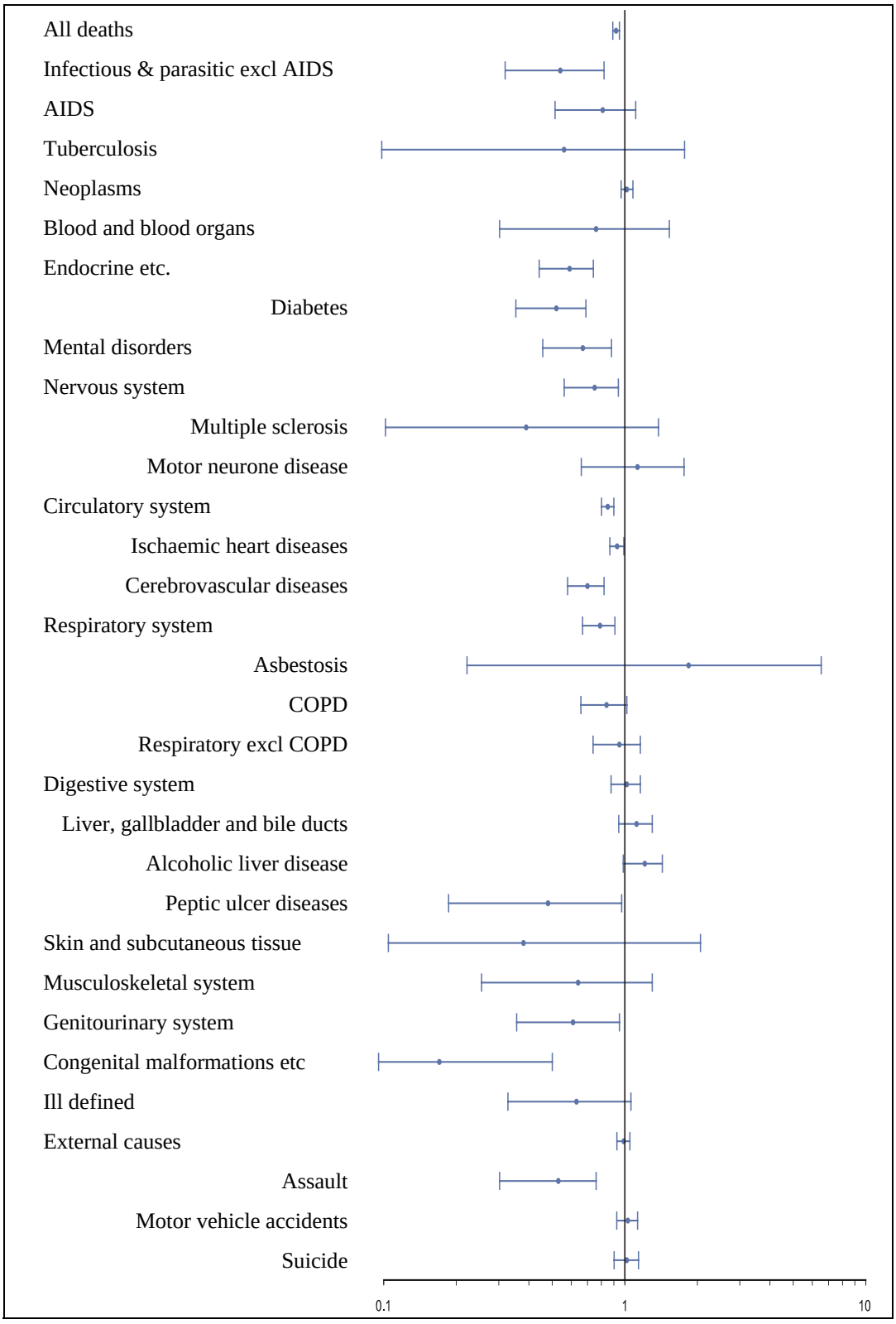


Figure 6-3: Standardised Mortality Ratios (SMRs) and 95% CIs for Army Vietnam veterans

6.4.3 Mortality of Air Force Vietnam veterans

There were 686 deaths among the 4,570 Air Force Vietnam veterans. As for all Vietnam veterans, the most common causes of death were from neoplasms (245), circulatory diseases (234) and external causes of death such as suicide and motor vehicle accidents (98), comprising 84% of all observed deaths.

Air Force veterans had an overall mortality which was 9% significantly lower than expected, SMR 0.91, (95% CI 0.42, 0.98). The SMR and 95% CI for all causes of death and 31specific causes are shown in Figure 6-4.

None of the causes of mortality analysed showed a higher than expected rate for Air Force veterans. However, mortality from several causes of death was significantly lower than expected and these are listed in Table 6-6.

Table 6-6: Standardised Mortality Ratios (SMR) for causes of death which were significantly lower than expected: Air Force Vietnam veterans

Cause of Death	Number of deaths	SMR	95% CI
All deaths	686	0.91	0.84, 0.98
Diabetes	6	0.46	0.17, 0.98
Circulatory diseases	234	0.87	0.76, 0.98
Ischaemic heart disease	161	0.86	0.73, 0.99
Respiratory diseases	28	0.64	0.40, 0.88

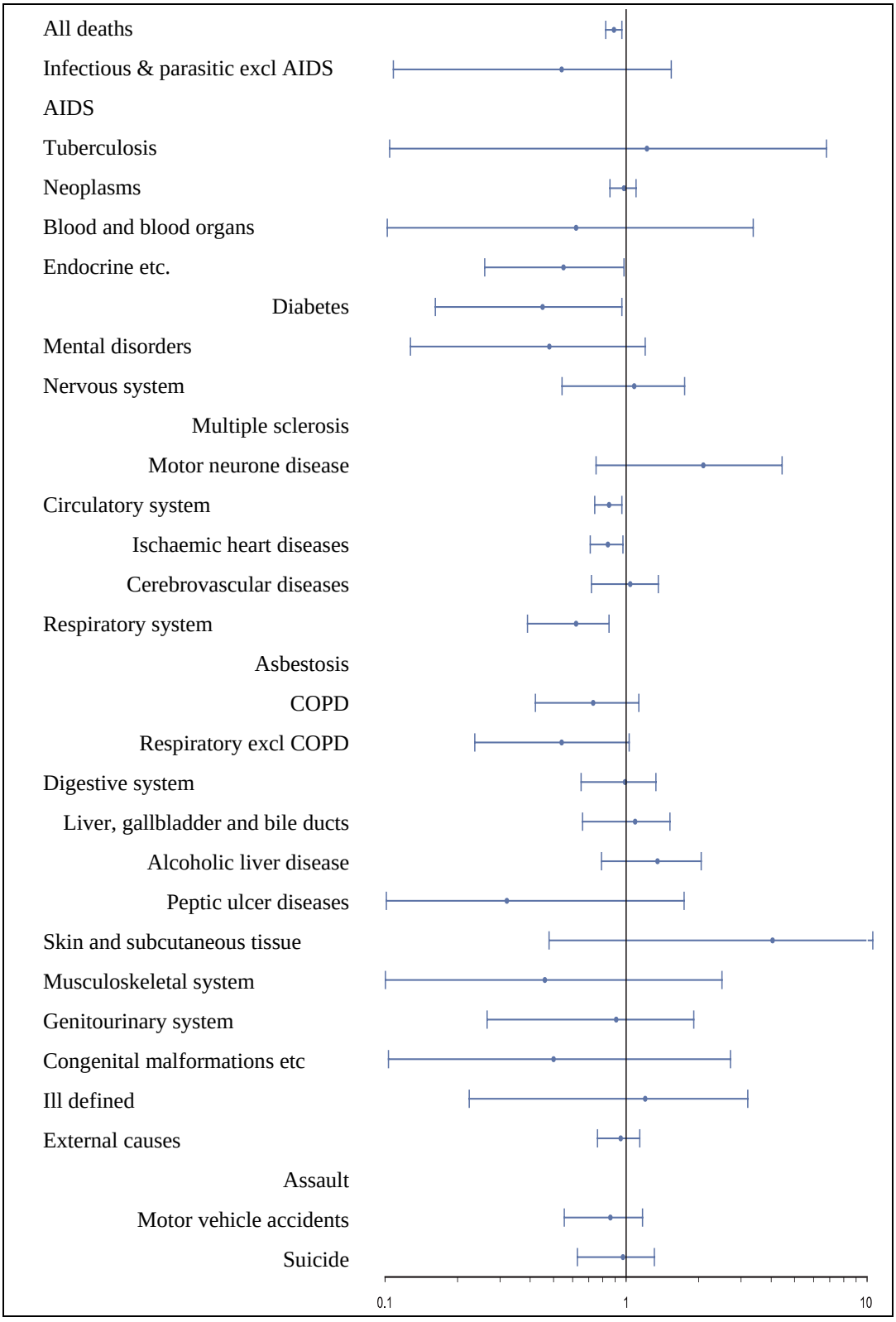


Figure 6-4: Standardised Mortality Ratios (SMRs) and 95% CIs for Air Force Vietnam veterans

6.5 Mortality from Neoplasms

Mortality from all neoplasms was investigated by individual primary site. Table D5, Appendix D lists the SMR and 95% CI for 32 different cancers for all Vietnam veterans.

There were 2058 deaths due to neoplasms accounting for 33% of all deaths among Vietnam veterans. The most frequently occurring causes of cancer deaths were lung cancer (544), gastrointestinal cancers (329) and genitourinary cancers (197).

Overall cancer mortality and a number of individual cancer sites were of *a priori* interest for Vietnam veterans. These results are listed in Table 6-7. Mortality from cancer was 6% higher than expected among Vietnam veterans compared to the Australian male population, but this was of statistical significance for Scenario 1 only, SMR 1.06, (95% CI 1.02, 1.11).

Mortality from one individual cancer of *a priori* interest was significantly lower than expected (non-Hodgkin's lymphoma) and two rates were significantly higher than expected (lung cancer and head and neck cancer). In addition, mortality from cancer of the oral cavity, pharynx and larynx, which includes head and neck cancer, was significantly higher than expected. There was also increase in mortality from prostate cancer, which was of borderline significance.

The SMR and 95% CI for all neoplasms and 32 specific cancers among all Vietnam veterans are shown in Figure 6-5.

Table 6-7: Standardised Mortality Ratios (SMR) for cancers of *a priori* interest: Vietnam veteran cohort

Cause of Death	Number of deaths	SMR	95% CI
Neoplasms	2,058	1.06	1.02, 1.11
Bladder cancer	22	0.71	0.42, 1.01
Brain cancer	99	0.95	0.76, 1.13
Breast cancer	4	2.15	0.58, 5.42
Connective and soft tissue cancer	12	0.75	0.38, 1.28
Gastrointestinal cancers	329	0.96	0.86, 1.06
Head and neck cancers	101	1.44	1.16, 1.73
Hodgkin's disease	13	0.89	0.46, 1.49
Leukaemia	84	1.07	0.84, 1.30
Lung cancer	544	1.18	1.08, 1.28
Liver cancer	48	0.88	0.63, 1.13
Melanoma	111	1.10	0.90, 1.31
Multiple myeloma	24	0.86	0.52, 1.20
Non-Hodgkin's lymphoma	70	0.78	0.60, 0.96
Prostate cancer	107	1.23	0.99, 1.46
Testicular cancer	14	0.85	0.43, 1.39
Thyroid cancer	2	0.51	0.06, 1.78

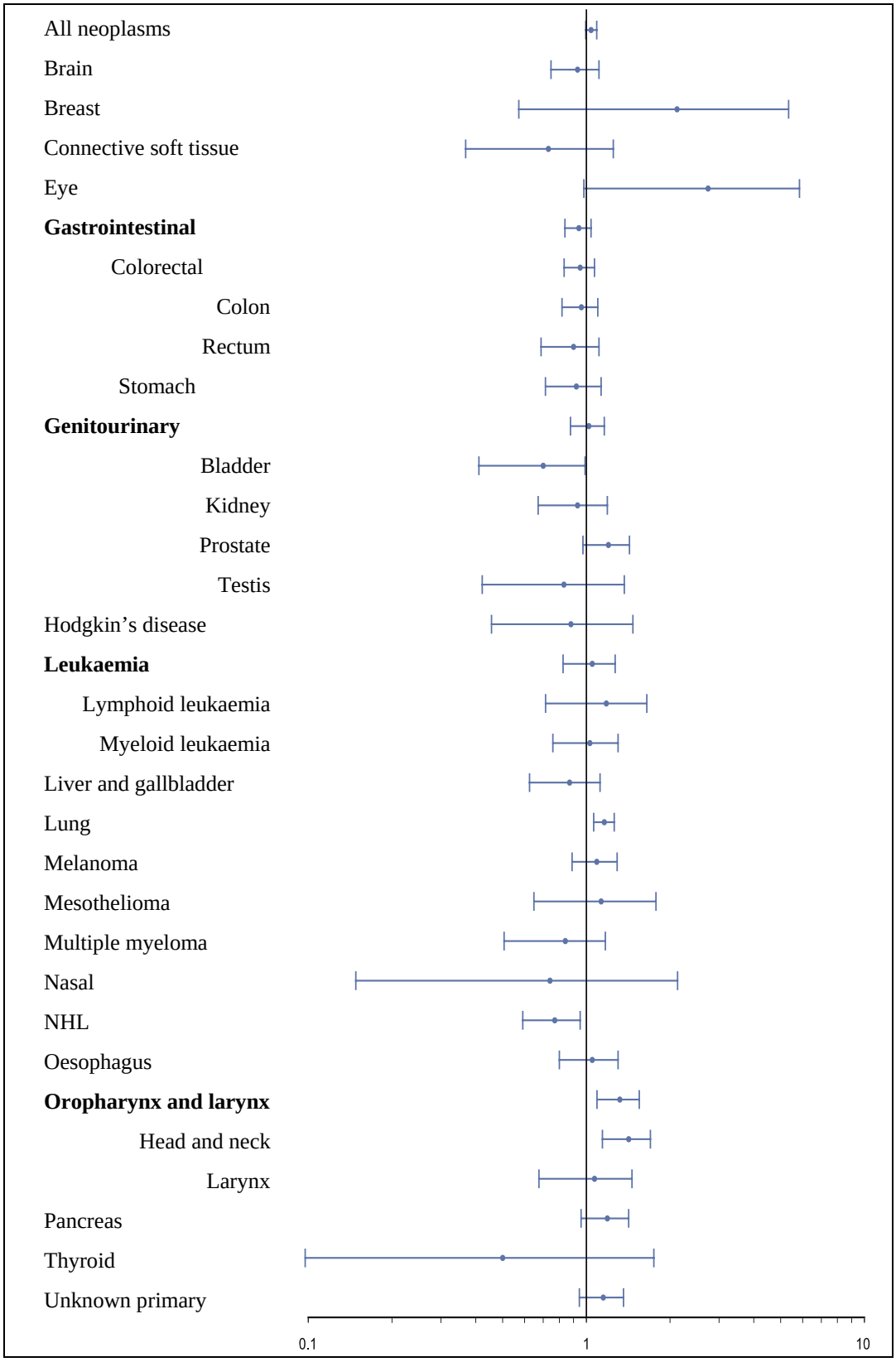


Figure 6-5: Standardised Mortality Ratios (SMR) and 95% CIs for cancer deaths amongst all Vietnam veterans

6.5.1 Cancer mortality among Navy Veterans

Table D6, Appendix D shows the distribution of the 491 deaths from neoplasms among the Navy Vietnam veterans. The most frequently occurring causes of cancer deaths were from lung cancer (135), gastrointestinal cancer (86) and genitourinary cancer (43).

Overall Navy veterans had a 19% significantly higher than expected mortality from neoplasm. Specifically, mortality from lung cancer, melanoma and mesothelioma were higher than expected whereas death from non-Hodgkin's lymphoma was lower than expected. Table 6-8 shows the results. Mortality from all other cancers analysed did not differ from expectation.

Table 6-8: Standardised Mortality Ratios (SMR) for cancer deaths which were significantly lower or higher than expected: Navy Vietnam veterans

Cause of Cancer Death	Number of deaths	SMR	95% CI
Non-Hodgkin's lymphoma	10	0.52	0.25, 0.94
Lung	135	1.39	1.15, 1.62
Melanoma	35	1.56	1.04, 2.08
Mesothelioma	8	2.53	1.11, 4.94
All neoplasms	491	1.19	1.08, 1.29

6.5.2 Cancer mortality among Army Veterans

Table D7, Appendix D shows the distribution of the 1,323 deaths from neoplasms among the Army Vietnam veterans. The most frequently occurring causes of cancer deaths were from lung cancer (339), gastrointestinal cancer (206) and genitourinary cancer (122).

Overall mortality from neoplasms among Army veterans was not significantly different from the Australian population. There were no individual cancers for which mortality was lower than expected. However, mortality from lung cancer (Scenario 1 only), cancer of the oral cavity, pharynx and larynx and its subgroup, head and neck cancer was higher than expected. Mortality from eye cancer was also significantly higher than expected based on 5 deaths. Table 6-9 shows the results. Mortality from all other cancers analysed did not differ significantly from the Australian population.

Table 6-9: Standardised Mortality Ratios (SMR) for cancer deaths which were significantly higher than expected: Army Vietnam veterans

Cause of Cancer Death	Number of deaths	SMR	95% CI
Eye	5	3.43	1.09, 7.85
Lung	339	1.13	1.01, 1.25
Oral cavity, pharynx and larynx	88	1.39	1.10, 1.68
Head and neck	69	1.49	1.14, 1.84

6.5.3 Cancer mortality among Air Force Veterans

Table D8, Appendix D shows the distribution of the 245 deaths from neoplasms among the Air Force Vietnam veterans. The most frequently occurring causes of cancer deaths were from lung cancer (71), gastrointestinal cancer (38) and genitourinary cancer (32).

Overall mortality from neoplasms amongst Air Force veterans was not significantly different from the Australian population. Among individual cancers mortality from stomach cancer was significantly lower than expected, SMR 0.41, (95% CI 0.10, 0.98). Mortality from all other cancers analysed was not significantly different from expectation. However, there was a marked but non-significant elevation in mortality from lymphoid leukaemia (six deaths identified where two were expected).

In summary, Figure 6-6 compares the SMR and 95% CI for selected cancers by Service branch.

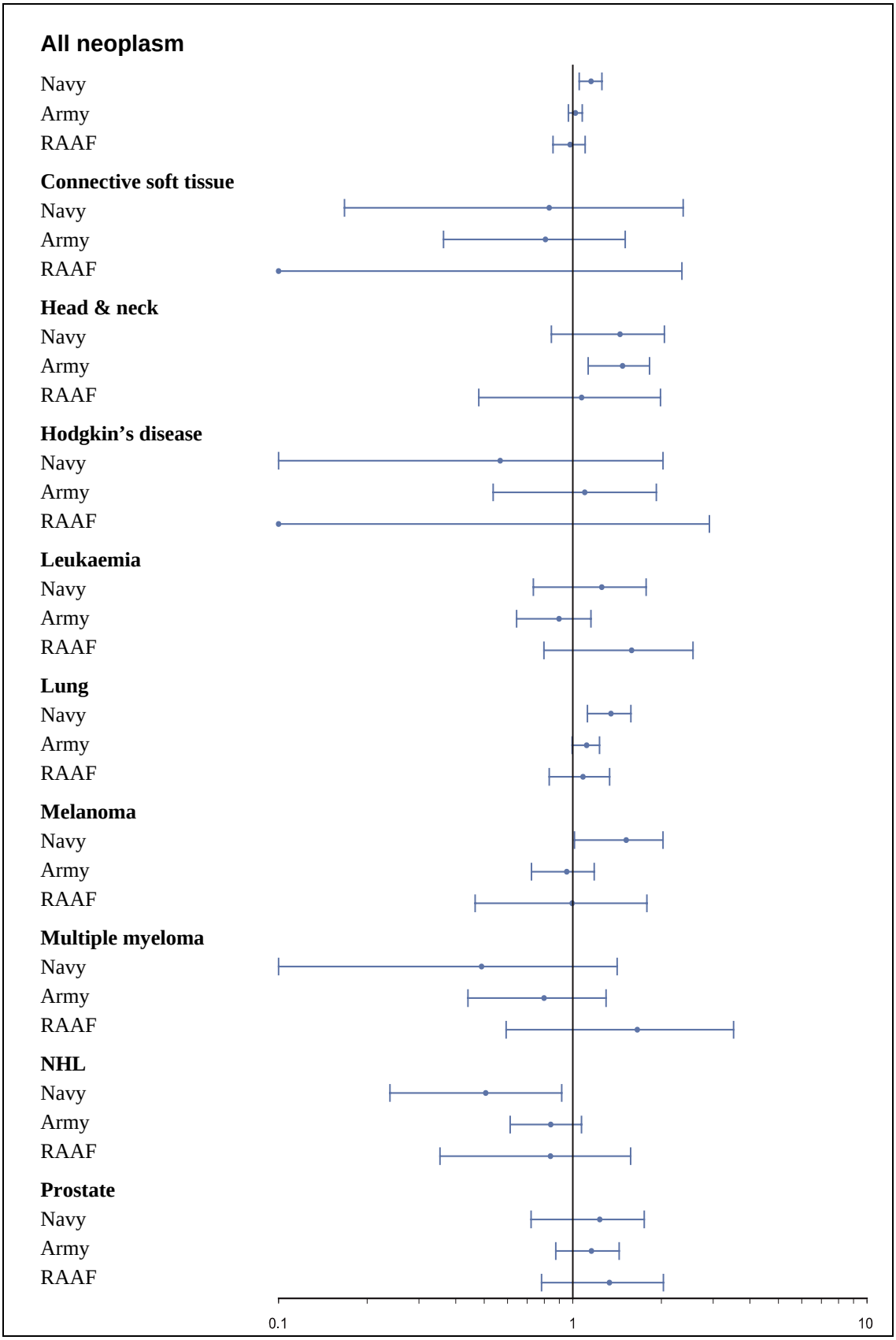


Figure 6-6: Standardised Mortality Ratios (SMRs) and 95% CIs for selected cancers by Service branch

6.6 Change in mortality over time

As is discussed more fully in Chapter 7, consideration of the healthy worker effect is important for interpreting the results of this mortality study. Briefly, Vietnam veterans were a selected group of healthy, fit men at the time of the commencement of their service. Thus they would be expected to have a lower mortality compared to the Australian community which includes men at all levels of fitness and health. This effect diminishes with time from enlistment and is more pronounced for certain disease groups, such as some congenital diseases, that would have been screened for at enlistment.

Table 6-10 illustrates the change in SMR over time for all Vietnam veterans for selected disease groups. The time in follow-up is divided into three periods of approximately one decade each. The results in Table 6-10 show that, in general, standardised mortality ratios increased over time and the overall mortality ratio in the most recent period was SMR 0.99 (95% CI 0.96, 1.02). With the exception of circulatory and infectious diseases, the mortality rates were not significantly lower than the Australian community in the latest time period. Thus, although over the more than thirty years of follow-up in this study overall mortality and mortality for many of the disease groups analysed were significantly lower than expectation, in the most recent decade mortality ratios generally were not different from expectation.

The mortality from external causes was stable over time and reflects a decrease in deaths from motor vehicle accidents and an increase in mortality from suicide. Mortality from diseases of the liver, gall bladder and bile ducts and specifically alcoholic liver disease were significantly higher than expected in the latest time period, SMR 1.25, (95% CI 1.04, 1.47) and SMR 1.48, (95% CI 1.20, 1.76), respectively.

Table 6-11 describes the change in SMR for selected cancers. The change in cancer mortality over time showed a mixed pattern. The mortality from some cancers, such as all neoplasms, cancer of the eye, colon, and to a lesser extent pancreas showed the highest mortality rate in the middle time period from 1980 to 1990, although not all these values were statistically significant. In the latest time period mortality from all neoplasms, cancers of the prostate, lung, and oral cavity, pharynx and larynx were significantly higher than expected. Also mortality from Hodgkin's disease and melanoma were non-significantly elevated in the latter time period.

It is important to note that many cancers have a long latency period from exposure to any possible etiological factor to disease development. The majority of cancers would develop decades after any exposure to potential carcinogens.

Table 6-10: Change in SMRs over time for all Vietnam veterans

	1963 – 1979				1980-1990				1991-2001			
Cause of death	**Observed**	**Expected**	**SMR**	**95% CI**	**Observed**	**Expected**	**SMR**	**95 % CI**	**Observed**	**Expected**	**SMR**	**95% CI**
All deaths	1,059	1,291	0.82	0.77–0.87	1,751	1,853	0.95	0.90–0.99	3,356	3,386	0.99	0.96–1.02
Infectious diseases excluding aids	3	10	0.36	0.06–0.92	8	13	0.64	0.28–1.24	21	31	0.69	0.40–0.98
Neoplasm diseases	145	177	0.82	0.68–0.95	553	492	1.12	1.02–1.21	1,360	1,266	1.07	1.02–1.13
Circulatory diseases	186	271	0.69	0.59–0.79	546	622	0.88	0.80–0.95	1,035	1,114	0.93	0.87–0.99
Ischaemic	124	177	0.70	0.58–0.82	421	443	0.95	0.86–1.04	753	764	0.99	0.92–1.06
Stroke	35	43	081	0.54–1.07	59	81	0.73	0.54–0.92	129	156	0.83	0.69–0.97
Respiratory diseases	8	44	0.19	0.08–0.36	58	79	0.74	0.55–0.93	173	187	0.93	0.79–1.06
COPD[1]	N/A				30	36	0.85	0.55–1.15	97	113	0.86	0.68–1.03
Respiratory minus COPD	N/A				27	44	0.62	0.39–0.85	76	74	1.03	0.80–1.27
Digestive diseases	36	42	0.86	0.58–1.14	87	95	0.92	0.73–1.12	170	147	1.16	0.98–1.33
Liver, gall bladder and bile ducts	23	27	0.87	0.52–1.22	64	70	0.91	0.69–1.14	134	105	1.27	1.06–1.49
Alcoholic liver disease	15	16	0.96	0.53–1.57	40	47	0.85	0.59–1.12	108	73	1.48	1.20–1.76
Musculoskeletal diseases	0	2	0.00	0.00–1.80	2	4	0.50	0.06–1.77	8	11	0.77	0.34–1.50
Genitourinary diseases	3	11	0.29	0.06–0.81	5	9	0.54	0.17–1.23	21	25	0.87	0.50–1.23
Congenital diseases	1	10	0.10	0.00–0.55	1	6	0.17	0.00–0.95	4	9	0.44	0.12–1.12
Unknown causes diseases	4	11	0.37	0.09–0.89	8	8	0.97	0.43–1.91	10	11	0.95	0.45–1.73
External diseases	652	650	1.00	0.93–1.08	416	414	1.00	0.91–1.10	327	327	1.00	0.89–1.11
Assault	9	20	0.47	0.20–0.84	13	21	0.64	0.33–1.07	8	14	0.58	0.25–1.12
MVA	374	338	1.11	1.00–1.22	123	130	0.94	0.78–1.11	56	67	0.83	0.61–1.05
Suicide	112	130	0.86	0.70–1.02	150	142	1.06	0.89–1.23	159	139	1.15	0.97–1.33

[1] COPD – chronic obstructive pulmonary disease

Table 6-11: Change in cancer mortality over time for all Vietnam veterans

	1963 – 1979				1980-1990				1991-2001			
Cause of cancer death	**Observed**	**Expected**	**SMR**	**95% CI**	**Observed**	**Expected**	**SMR**	**95 % CI**	**Observed**	**Expected**	**SMR**	**95% CI**
All neoplasms	145	177	0.82	0.68–0.95	553	494	1.12	1.02–1.21	1,360	1,266	1.07	1.02–1.13
Brain and CNS	13	16	0.81	0.39–1.33	30	30	1.02	0.66–1.39	56	59	0.94	0.70–1.19
Eye	1	0	4.77	0.11–25.21	3	1	5.40	1.10–15.53	2	1	1.44	0.17–5.11
Gastrointestinal	22	26	0.84	0.49–1.19	98	90	1.08	0.87–1.30	209	226	0.92	0.80–1.05
Colon	16	14	1.16	0.62–1.81	64	47	1.37	1.04–1.71	97	120	0.81	0.64–0.97
Colorectal	18	19	0.95	0.53–1.44	76	65	1.17	0.91–1.43	153	173	0.89	0.75–1.03
Genitourinary	12	16	0.73	0.34–1.23	37	37	0.98	0.66–1.30	148	135	1.10	0.92–1.28
Prostate	1	1	0.77	0.02–4.05	11	13	0.89	0.44–1.57	94	73	1.29	1.03–1.55
Hodgkin’s	3	7	0.44	0.09–1.21	4	5	0.87	0.23–2.19	6	3	2.04	0.74–4.37
Leukaemia	17	15	1.10	0.60–1.70	22	22	1.01	0.59–1.43	45	41	1.08	0.77–1.40
Lung	17	29	0.59	0.32–0.90	151	121	1.25	1.05–1.45	376	312	1.21	1.08–1.33
Melanoma	16	17	0.93	0.49–1.45	35	32	1.08	0.72–1.44	61	52	1.18	0.88–1.47
Mesothelioma	N/A				N/A				18	15	1.22	0.71–1.89
NHL	8	10	0.85	0.36–1.59	23	23	1.01	0.60–1.42	39	57	0.67	0.46–0.89
Oesophagus	4	3	1.62	0.42–3.93	15	13	1.20	0.66–1.95	48	48	1.00	0.71–1.28
Oral cavity, pharynx and larynx	3	6	0.53	0.10–1.46	33	26	1.26	0.82–1.69	93	64	1.45	1.16–1.75
Pancreas	5	6	0.92	0.28–2.04	30	20	1.49	0.96–2.02	65	57	1.14	0.86–1.41
Unknown	9	6	1.69	0.73–3.03	23	25	0.95	0.57–1.34	87	73	1.20	0.95–1.46

6.7 Summary

This chapter presented the results of the mortality analysis for Vietnam veterans from the time they returned from Vietnam to December 2001. Overall Vietnam veterans had a 6% lower than expected mortality rate compared to the Australian male population. However, the difference in mortality between the two groups was no longer present in the most recent time period.

The most common causes of death were cancer, circulatory diseases and external causes such as suicide and motor vehicle accidents and this was consistent across the Service branches.

Of the nine non-neoplastic causes of death of *a priori* interest, the mortality rates of three (infectious diseases, ischaemic heart disease and neurological diseases) were significantly lower compared to the Australian population. Mortality rates from digestive disease, chronic obstructive pulmonary disease (Scenario 1 only), motor neurone disease, suicide and motor vehicle accidents did not differ from expectation. A significantly higher mortality from alcoholic liver disease was observed for Vietnam veterans in Scenario 1, which was particularly evident in the most recent time period.

In addition, of the 36 causes of death analysed, Australian Vietnam veterans had a lower than expected mortality from several of the specific causes, including mortality from circulatory diseases, respiratory diseases and infectious diseases. However this difference from expectation had essentially disappeared in the most recent time period analysed.

Of the three Services, mortality amongst Navy veterans was not significantly different from the Australian population but their mortality from cancer was 19% higher than expected. Overall mortality amongst Army and Air Force veterans was significantly lower than expected and no single non-cancer cause of death was significantly elevated under either analysis Scenario. Mortality was significantly lower than expected for diabetes and respiratory diseases across all Services, and Army and Air Force veterans also had lower than expected mortality for circulatory diseases.

Mortality from specific cancers was investigated. Although statistically significant in Scenario 1 only, overall cancer mortality was 6% higher than expected. Mortality from lung cancer and cancer of the head and neck region was significantly higher than expected, whereas mortality from non-Hodgkin's lymphoma was lower than expected. Furthermore, mortality from cancers of the eye and prostate were borderline significantly elevated.

Amongst the Services cancer mortality was significantly elevated for Navy veterans only. However there were significant differences for individual cancers between the Services. There was a higher than expected cancer mortality from lung cancer, melanoma and mesothelioma amongst Navy veterans whereas Army

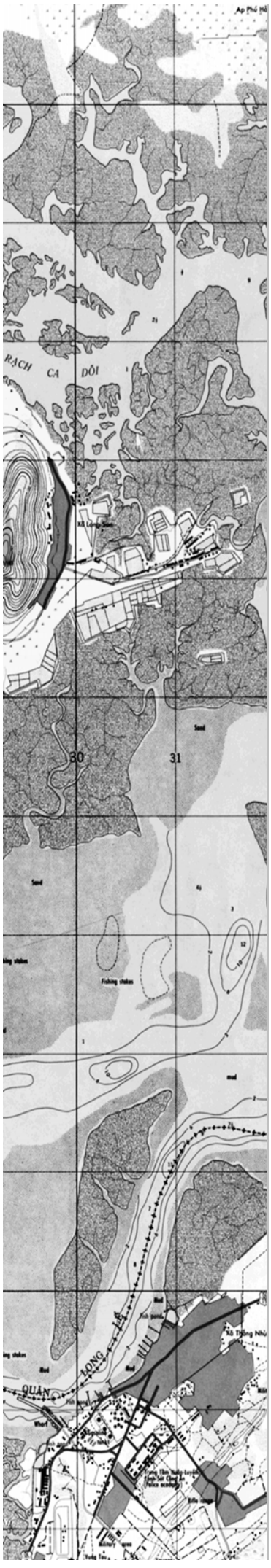
veterans had a higher than expected mortality from cancers of the eye, oral cavity, pharynx and larynx and head and neck.

The change in SMR over time was investigated. In general, standardised mortality ratios increased with increasing time from Vietnam service, illustrating a diminution of the healthy worker effect on this male military cohort. By the most recent decade the mortality for most of the causes of death analysed were no longer significantly lower than expectation. Mortality from neoplasms and liver disease was significantly higher than expectation in the latest time period. Mortality from prostate cancer was of borderline significance overall, and was significantly elevated in the most recent time period.

Chapter 7 discusses the results presented in this chapter in the context of community norms and findings of previous studies.

References:

1 Australian Bureau of Statistics, *Causes of Death* cat no. 3303.0, Canberra, 2000.



7

Summary and Discussion

Chapter 7 Summary and Discussion

This is a retrospective mortality study of all male military Australian Vietnam veterans. It follows the mortality of these veterans from the time they completed their Vietnam service to 31 December 2001. This represents over 30 years of follow-up for this cohort.

7.1 Features of the study

This study has a number of features that are inherent in a retrospective epidemiological study of a military cohort and other features that are unique to this study.

This was a large study, with nearly sixty thousand men followed for up to 38 years, providing almost 1.9 million person-years of follow up. The study population was racially homogenous, and all were male. This reduces inter-group variability and improves comparisons.

Among the other strengths are the high proportion of veterans whose vital status could be ascertained. Further, the number whose vital status could not be ascertained was much smaller than the number of veterans who had died. Thus the distorting effect of those with unknown vital status as a proportion of those known to be alive or dead would be minimal.

The study has a number of limitations. Firstly, as with any mortality study, there are many diseases, causes of disability and aspects of health that are not measured by a mortality study.

Secondly, the study has little information about exposures during service in Vietnam. Although this cohort was exposed to a range of stresses and toxicants, little is known about the amount of exposure that either each veteran or group of veterans experienced. In effect, it describes an overall average exposure of the Vietnam experience. In addition any adverse or beneficial health exposures an individual may have experienced following Vietnam service are also not known or quantified.

A major feature to be considered when assessing the results of this study was the existence of a healthy worker effect, which is discussed in the next section.

7.2 Healthy worker effect

The healthy worker effect (HWE) is a phenomenon observed in occupational health studies in which those who are employed exhibit a lower mortality rate than the general population. This effect is often primarily attributed to a selection bias whereby employed people are, on average, healthier than the general population, which includes those who are severely ill or disabled and may be unable to work. However, there are a number of other factors that contribute to and can modify the HWE. This section discusses aspects of this phenomenon in general and with special reference to a military cohort.

The HWE is often referred to as the 'healthy soldier effect' for occupational studies of military cohorts. This distinction denotes the fact that military populations are far healthier than the other employed populations, which in turn are healthier than the general population consisting of those employed and unemployed. This higher level of health and fitness is due to the active screening of those with chronic illnesses undertaken at enlistment into the military and the ongoing requirement to maintain good physical and mental health while serving (the active worker effect).[1] Haley[2] takes this concept further, coining the phrase 'healthy warrior effect', for those military personnel deemed fit for deployment to a war zone and who thus have undergone another level of health screening beyond those not deployed.

Many factors can modify the magnitude of the HWE. Within a study population the HWE does not apply equally to all subgroups. There is variation in this effect between different age groups, job status, and ethnic background or race.[3] For example, in the Vietnam veteran cohort there would be variation in fitness requirements between different jobs within a Service branch and between the Services, which not only have different enlistment criteria but different job profiles. This includes variation in socio-economic and educational levels and other potential exposures in addition to fitness levels.

Furthermore, subsequent employment and lifestyle following the occupation under study will influence the size of the effect in subtle and complex ways.[1, 4] Employment following Vietnam service could benefit fitness and health and thus increase the HWE (such as remaining in the military with high fitness standards and routine health checks) or be detrimental to health and lessen the observed HWE (such as unemployment or work in a hazardous industry following service). Lifestyle factors such as smoking can be a multifaceted influence on the HWE. Smoking can be considered as a confounder, an effect modifier or on the causal pathway of the health consequences of Vietnam service. One study has reported that a subgroup of Army Vietnam veterans smoked more than the Australian population[5] and thus smoking should be considered a confounder to the assessment of mortality within this group. Yet smoking could also be an effect modifier by exasperating any potential carcinogenic effect of the work environment such as with the multiplicative effect of smoking and asbestos exposure.[6] In addition, combat veterans who were given cheap or free cigarettes may have taken up smoking as a result of service. Thus smoking might be seen as an intermediate on the causal pathway between service in Vietnam and cancer.

Length of follow-up of an occupational cohort can also influence the observed HWE. Although it is uncertain how long the HWE lasts there is general agreement that the effect is more pronounced in the early years of follow-up, with the exception of a peak in mortality in the period immediately following termination of employment.[7] Various studies have reported the effect to last from five[8] to fifteen[9] years or to still be noticeable after 41 years of follow-up.[10] In studies of military populations, Seltzer[11] observed a 57% reduction in mortality in the first 1-5 years of follow-up which reduced to 14% by 23 years. Similar increases in SMRs over time were noted in a study by Darby et al[12] of British servicemen who served abroad in the 1950s and 1960s. In this study of Vietnam veterans the results in Table 6-10 support this time-related effect showing the lowest SMRs for the Vietnam cohort in the first decade following Vietnam service.

The HWE does not affect all causes of death equally. Researchers generally regard the effect as small for cancer mortality and large for those diseases that occur early in life or are manifest at the time of employment.[13] The disease specific modification of the HWE is also dependent on specific employment criteria of some occupations. For example, military personnel and firefighters would be excluded from employment if they had diabetes, which would reduce the mortality from endocrine disorders. As diabetes is also a known risk factor for heart disease, a deficit in mortality for this group of diseases could also be observed.[14] Generally, the cause-specific deficits in mortality are most prominent for cardiovascular diseases, diabetes and respiratory diseases.[6]

Quantification of the HWE has been a subject of much debate. Researchers in the field have estimated the HWE would reduce the standardised mortality rate across various occupations by 10% to 30%.[13] Long term follow-up studies of military personnel have shown a reduction in overall mortality between 11% to 17%. Muirhead et al[15] found that the standardised mortality of British servicemen who served in the United Kingdom's nuclear test program was 0.89 and 0.88 for a control group of servicemen. A British study of submariners of the United Kingdom also showed a significantly lower all-cause mortality, with an SMR of 0.86.[16] Similarly, a study of World War II veterans followed up for more than 23 years after service showed an overall mortality of 0.83.[11] In contrast, a fifty year follow-up of Australian veterans of the Korean War has shown a 21% higher than expected overall mortality rate.[17]

Occupational epidemiologists have debated whether it is appropriate to adjust the observed results for the HWE. Some have developed mathematical models which attempt to account for very specific aspects of the HWE.[18, 19] However, given the complex and subtle nature of the many factors which can influence the HWE, the validity of a broad adjustment procedure is highly debatable and it would make the results harder to interpret.

In summary, the results of a retrospective study of deployed military personnel are affected by the HWE. Employment selection and a multitude of other factors such as subsequent employment, lifestyle, ethnic background, age and length of follow-up influence this effect which may not be equal for all causes of death. This must be borne in mind when interpreting the results.

7.3 Comparison with previous mortality studies

7.3.1 Differences between the findings of this study and previous mortality studies

There have been several previous mortality studies of Australian veterans. The first of these reported in 1984 was called *A retrospective cohort study among Australian National Servicemen of the Vietnam Conflict Era*, but for the purpose of this discussion it will be referred to as the 1984 Report.[20] The second report was called the *Mortality of Vietnam veterans – the veteran cohort study* and will be referred to as the 1997 Report.[21] The study presented in this volume is the third mortality report of Australian Vietnam veterans.

There are several critical factors that affect the comparison of results between studies:

(1) the population under study,
(2) the period in which they were followed,
(3) the ability to ascertain vital status of the veterans and determine their cause of death, and
(4) the methods applied in the data analysis.

While these factors focus on technical aspects of the project, it is important to note that the studies were commissioned independently and they were not designed to be directly compared. The studies were conducted under three different organisational arrangements, but a core team of advisers assisted with the studies to provide some consistency. However, the quality of data has changed over time with improved knowledge of veterans' issues and improvements in methods and technologies to manage data.

7.3.2 Scope of the studies

Each of the three studies was conducted on somewhat different populations and in different time periods. This will determine the length of follow-up and the age of the cohort being studied, which in turn affects the ability of the study to assess different aspects of mortality.

The 1984 Report focussed only on National Servicemen within the Army and included approximately 19,000 Vietnam veterans. It assessed mortality from 1965 to 1982, giving 11 to 17 years of follow-up depending on date of enlistment. The age of the cohort during this study period would generally be under 40 years old. The study found a significant reduction in mortality for the Vietnam veterans with a SMR = 0.83 compared to the general population.

The second mortality study, the 1997 Report, included all military Vietnam veterans from the three Service branches and compared their mortality with that of the same aged Australian male population. In this study there were just over 57,700 military veterans; 41,000 Army, 12,300 Navy and 4,400 Air Force. Mortality was assessed from 1963 to 1994, giving 22 to 31 years of follow-up. The age range of this cohort from all three Service branches was much wider than

in the 1984 study of National Servicemen and at the end of the study period it ranged from approximately 40 to 75 years old. This study reported mortality ratios in two time periods, 1963 to 1979 and 1980 to 1994 and the adjusted overall mortality for Vietnam veterans for the period 1980-1994 only was significantly higher than expected, adjusted SMR = 1.07 (95% CI 1.02, 1.12).

The present study also included all military Vietnam veterans from the three Service branches. It assessed mortality from 1963 to 2001, giving 29 to 38 years of follow-up with an age range in 2001 between 47 years old to over 80 years of age. In the time since the 1997 Report, work had been done on the Nominal Roll of Vietnam Veterans, especially Navy personnel. As reported in Chapter 3, the veteran cohort was just over 59,000; 41,000 Army, 13,500 Navy and 4,500 Air Force. This study has determined that overall the all cause mortality for the Vietnam veteran cohort from 1963 to 2001 was significantly lower than expected, SMR = 0.94 (95% CI 0.92, 0.97). This effect varied, however, with the greatest reductions seen in 1963 - 1979 (SMR = 0.82) and no reduction evident in the most recent time period, 1991 - 2001 (SMR = 0.99).

While the base methodology remained the same throughout the studies, variations in methods were introduced in response to improvements in technology and the changing quality of data.

In large part the 1984 study used manual matching to federal, state and territory databases for the determination of vital status. Some computer matching was used but was based on exact matches only.

In the 1997 study mortality rates were presented for two time periods, mortality prior to 1980 and mortality for the period 1980 - 1994, which is the period that was covered by the National Death Index and contained more complete data. Comparing the client database of the Department of Veterans' Affairs with the results of matching to the National Death Index determined that under-ascertainment of deaths was occurring. The extent of under-ascertainment was thought to vary with different causes of death and between the Services. Mathematical models were developed that adjusted for this variable under-ascertainment and the adjusted results were presented in the report.

In the current study, using a greater number of sources for data matching and better matching algorithms, more deaths were identified (See Appendix E). With this improved method of data collection, the research team was more confident that the current study does not have any appreciable under-ascertainment of deaths.

7.3.3 The 1984 Report

Of the three studies, the results of the 1984 Report are most likely to be affected by the healthy worker effect, as follow-up was closest to the time of military service. The SMR of 0.83 reported in the 1984 Report is almost identical to that of 0.82 reported for the comparable time period in the present study. The fact that the overall SMR from the present study and the SMRs for the more recent time periods (presented in Table 6-10) are much greater than the 1984 value suggests

that much of the reduction in mortality seen in 1984 is indeed due to the healthy worker effect.

An additional factor in the 1984 study is that nearly five percent of the cohort had been lost to follow-up whereas only slightly over one percent of the group was found to be dead. In comparison, in the present study only 2.7% of the cohort were of unknown vital status and 10.8% were determined to have died. The smaller the proportion of the cohort lost to follow-up and the larger the proportion determined to have died, the more stable are the results to any variability in ascertainment of vital status.

7.3.4 The 1997 Report

As discussed above, the results of the 1997 study were adjusted to compensate for the under-ascertainment of deaths. In this study the adjusted overall mortality for Vietnam veterans for the period 1980-1994 was significantly higher than expected, adjusted SMR = 1.07 (95% CI 1.02, 1.12). The unadjusted ratio was 0.90, which is slightly lower than the findings of the present study indicating that some degree of under-ascertainment did occur in the last study.

In the current study, a much greater proportion of the cohort had died, and the relative proportion of those whose vital status cannot be found was reduced. Additional checks on the accuracy of the NDI matching also suggested that this had a very high sensitivity and few deaths were likely to have been missed (see Appendix E). In light of this and the results of the present study, it is believed that the adjustment in the 1997 Report over compensated for under-ascertainment, and that the rates of death reported in that study were inflated.

7.3.5 Summary

Although, as with any probabilistic matching techniques, it is highly likely that this study has missed a small number of deaths and may have included deaths that should not have been attributed to veterans, it is believed that a highly robust approach to data linkage has been undertaken which balances these issues. This study should be seen as supplanting the previous study.

7.4 Overall mortality

This study found that overall Australian veterans of the Vietnam War had a mortality that was 6% below that of the Australian male population. This reduction was greatest in the early years since service (18%) and had disappeared by the most recent period, approximately 20 - 38 years following service when mortality amongst the veterans was no different from expectation (SMR = 0.99).

Among the single causes of death investigated in this population of Vietnam veterans, the most common was ischaemic heart disease, although all neoplasms taken together resulted in a higher number of deaths. Deaths due to external

causes (which includes homicides, suicides and motor vehicle accidents) were also common. These patterns are generally very similar to the patterns found in the Australian community.[22]

7.5 Non-cancer mortality of *a priori* interest

As discussed in Chapter 1, specific *a priori* causes of death were selected for investigation through the examination of the literature and concerns of the veteran community. This section discusses the mortality results from those non-cancer *a priori* diseases of interest. Section 7.6 discusses cancer mortality of *a priori* interest.

7.5.1 Infectious diseases, HIV and Tuberculosis

In Western society, infectious disease has become a relatively rare cause of death and amongst Vietnam veterans, death rates from this disease group were lower than expected.

The period under consideration in this study was the period of the start of the HIV/AIDS pandemic, which has increased the death rate within the infectious disease group in many countries. However, mortality from AIDS within Australia is relatively low.[23]

The main risk factors for contraction of HIV infection are receipt of contaminated blood products, such as for haemophilia, unprotected homosexual activity and sharing of needles during intervenous drug use. The first two risk factors would be reduced among Vietnam veterans as haemophiliacs are not eligible for military service and practicing homosexuals were discouraged from joining the military at that time. The level of intravenous drug use among this cohort is not known.

There are not enough deaths to make meaningful observations about the infectious disease, tuberculosis. In this study the number of both expected and observed deaths are both small and similar, five and six respectively, and the confidence intervals of the SMR are therefore wide and straddle unity. While little meaning can be given to these figures, they provide some evidence that death from tuberculosis among Vietnam veterans was little different from expectation.

7.5.2 Ischaemic heart disease

Although this cause of death has been steadily declining in Australia, it remains the most common single cause of death in the Australian community (although all cancer when grouped together, is more common).[22] It is also the most common cause of death among Vietnam veterans. It resulted in 21% of all deaths among Vietnam veterans, based on 1,297 observed deaths. This is 87 fewer deaths than would be expected had Australian Vietnam veterans died from IHD at the same rate as Australians in general and, resulted in a SMR of 0.94 (95% CI 0.89, 0.99). There is a marginally significant but important reduction in mortality from IHD in

this group. This overall decrease in mortality can be attributed to a marked reduction in the first decade of follow-up. Mortality from IHD over the last two decades did not differ from expectation.

This early reduction in mortality from IHD is an important feature of many military populations. For example, Bullman *et al* in their study of the mortality of veterans who served in Military Region 1 in Vietnam (northern sector of South Vietnam) found a significant decrease in death from circulatory disease, with a PMR = 0.93 (95% CI 0.88, 0.98), p< 0.01.[24]

Several potential factors could contribute to the reduction in mortality for IHD. First, a selection bias could contribute as people suffering from a range of conditions that predispose to the later development of IHD, such as hypertension, diabetes and obesity are excluded from enlistment in military service. Following this, military service is an occupation that involves and encourages exercise. Furthermore, while continuing to serve, hypertension, dyslipidemia and diabetes may be screened for by the military medical system, and appropriate interventions would be made. Finally, veterans are often given privileged access to health care; this may allow for more effective treatment of IHD at the non-fatal stage.

These factors, as well as other features of Vietnam or military service and the healthy worker effect, may have played a role in the lower than expected mortality from IHD among Vietnam veterans.

7.5.3 Chronic obstructive pulmonary disease

This study found a borderline decrease in mortality from COPD, based on 128 observed deaths, against an expected number of 150. This provided an SMR of 0.85, which was of borderline statistical significance in Scenario 1 (95% CI 0.70, 1.00). It is perhaps important to note that observations about the mortality of this condition could only be made from 1979 onwards, when a change in the method of recording deaths allows this specific disease to be recorded separately.

While there are many causes of COPD, and in developing countries indoor pollution is an important factor, in Western countries the overwhelming cause of this condition is cigarette consumption.[25] Other factors, such as exposure to industrial dusts, may be a cause in a minority of cases, but it is difficult to see how service in Vietnam could have provided protection against such dusts. Genetic factors may also be important, but it is again difficult to see how service in Vietnam could have resulted in a population of people who were genetically protected from the development of COPD.

There is only limited information available about smoking habits in Australian Vietnam veterans. O'Toole *et al* compared the smoking habits of 641 randomly selected Army Vietnam veterans with the Australian male population in the early 1990's.[5] This study found that there was an increase in the number of veterans who still smoked (this elevation being present only after adjustment for under-ascertainment), and there was a significantly lower rate of veterans who had never smoked.

In summary, Australian veterans appear to have a marginally lower than expected mortality from COPD. One explanation for this observation is that veterans have enhanced access to health care.

7.5.4 Digestive diseases

Mortality from all digestive diseases and from one particular digestive disease, alcoholic liver disease, were of *a priori* interest for this cohort.

Overall, death rates from digestive diseases among Vietnam veterans were not different from the Australian population, SMR 1.03 (95% CI 0.91, 1.15). However in the most recent decade of observation the mortality from this group of diseases was elevated but of borderline statistical significance, SMR 1.16 (95% CI 0.98, 1.33).

Alcoholic liver disease

There was a significant elevation in the rate of death from alcoholic liver disease in Scenario 1. With 161 observed deaths as compared to 135 expected, there was an SMR of 1.19 (95% CI 1.01, 1.38). The main contribution to this elevation is from the most recent decade of follow-up and suggests this could be a growing problem within this cohort.

In the 1984 Mortality Study of conscripted Army veterans, there were six deaths from alcoholic liver disease among the veterans, and none recorded among the conscripts who did not serve in Vietnam.[20] Similarly, in the 1997 Report of National servicemen mortality, a significant increase in mortality from cirrhosis of the liver was observed.[21] However, in the 1997 study the mortality of all veterans (that is regular army as well as conscripts, Air Force and Navy), the rate of death from cirrhosis did not differ from expectation.

An American study of draft eligible men noted a significant decrease in mortality from alcoholic liver disease as compared to the general population. However there was no significant difference in mortality when veterans were compared to non-veterans.[26]

Jacobsen *et al* have reviewed the extensive literature in this area, and have concluded that "most published data support a pathway whereby PTSD precedes substance abuse or dependence".[27] Australian Vietnam veterans have been found to have an increased rate of PTSD,[28] and it could be argued that the results of the present study indicate they have developed PTSD with co-morbid alcohol misuse, eventually leading to an increase in alcoholic liver disease.

In summary, although the underlying contributing factors are not known, this study found evidence of an increase in the rate of death from alcoholic liver disease in veterans as compared to the general Australian population.

7.5.5 Neurological diseases

Mortality from diseases of the nervous system, in general, and motor neurone disease, in particular, was of *a priori* interest. Mortality from another important neurological disease, multiple sclerosis, is discussed in Section 7.7

Mortality from diseases of the nervous system among Vietnam veterans was significantly lower than expected, SMR 0.78 (95% CI 0.62, 0.94). This result is not unexpected amongst a veteran cohort as people with some diseases in this group, such as cerebral palsy, would be ineligible for military service. Mortality from other diseases, such as Parkinson's disease or Alzheimer's disease, would not be generally evident in a cohort of this age.

Motor Neurone Disease (MND)

Although this is a relatively rare disease sufficient time has passed to make observations about this degenerative disease of the nervous system. Twenty-five deaths from MND were observed; 24 would have been expected from Australian normative data. This gives an SMR of 1.06 (95% CI 0.64, 1.47).

Following a census of all Australian Vietnam veterans who could be located, which showed a substantial elevation in the self-report of this disease, the Department of Veterans' Affairs commissioned the AIHW to validate the reported level of MND[29]. Clinical information was gathered on all cases, and a panel of five expert neurologists examined this information before reaching a consensus on the diagnosis. The study concluded that the rate of MND was not statistically different to the Australian community norm.

This finding contrasts with a recent finding in the United States, which investigated the incidence of MND among over 500,000 men, 280,000 who served in the US military. The study found that veterans of all conflicts from WWII to Vietnam had almost double rate of MND compared to those who did not have military service.[30] Thus while American veterans seem to suffer from a higher risk of this disease, Australian Vietnam veterans have a risk that seems similar to the broader community. Similarly, results from the Australian Korean mortality study show mortality from MND to be no different than expected.[17]

7.5.6 Suicide

The rate of death from suicide was not significantly different to that found in the Australian male population, but there was a 15% increase of borderline significance in the most recent period. Based on a total of 421 deaths, the overall SMR was 1.03 (95% CI 0.93, 1.13). This finding is in contrast to the adjusted finding made in the previous mortality study[21], (SMR 1.21 (95% CI 1.02, 1.42), and reflects the improved methodology of this study as described in Section 7.3.

Research on suicide among Vietnam veterans has provided mixed results. Hearst et al[26] found an odds ratio of 1.65 (95% CI, 1.26-2.15), p = 0.0003, in a case-control study nested within a cohort study of draft eligible American men. Other

studies of the rate of suicide in American Vietnam veterans have shown both non-significant and significant elevations in suicide rates.[31-33]

However, the change in suicide mortality over time, as described in Section 6.6, suggests the mortality rate from this cause of death is increasing among the cohort. Price *et al* [34] found a suggestion of an increase in suicide over time among a cohort of Vietnam veterans with a history of drug use. In a study of prisoners of war from WWII and Korea, Port *et al* [35] found an increase in PTSD symptoms as the cohort aged. However O'Donnell [36] attributes poorer mental health in later life among a military cohort to individual health and socio-economic factors rather than military service.

7.5.7 Motor vehicle accidents

The mortality from motor vehicle accidents among Vietnam veterans did not differ from the rate seen in the Australian male population. However, the trend over time shows a decrease in mortality from this cause.

7.6 Cancer mortality of *a priori* interest

A number of individual cancers were of *a priori* interest for this study and are discussed below.

7.6.1 Lung Cancer

There was a significant elevation in lung cancer mortality, with a SMR of 1.18 (95% CI 1.08, 1.28). This elevation is consistent with the elevation in incidence reported in the cancer incidence report, where a significant increase in the incidence of lung cancer was noted.[37] It is also consistent with the previous mortality study which reported a 29% increase in the mortality rate of lung cancer.[21] Although there is some overlap between these three studies, taken together, they provide strong evidence that this cohort experiences an increased rate of lung cancer. Furthermore, as would be expected from the HWE and latency of this disease, the elevation is not observed in the first decade after service but becomes evident approximately 20 years after service.

This elevation in mortality from lung cancer has been observed in some earlier studies. A proportional mortality study found an elevation in mortality from lung cancer among both Army and Marine veterans.[32] Similarly, the Ranch Hand study of veterans responsible for spraying herbicides revealed a non-significant elevation in lung cancer, with a relative risk of 3.7 (95% CI 0.8, 17.1).[38]

A possible explanation for the elevated mortality rate from lung cancer among Australian Vietnam veterans may be that they smoked more, which is supported by a previous morbidity study.[5] However, individual data on smoking history is not available for this study and controlling for this major confounder among the Vietnam veteran cohort was not done. Although some researchers advocate an

indirect adjustment for smoking,[6] others feel the confounding effect of the differences of unmeasured lifestyle factors between two groups would most likely be modest.[39] In addition, in this military cohort smoking can be seen to be on the causal pathway as an increase in smoking rates could be attributable to Vietnam service.

Another possible explanation might be asbestos exposure. At the time of the Vietnam War, asbestos lagging was used extensively throughout Australian Navy ships, and this would have exposed the naval veterans and at least some of the Army (who were transported to and from Vietnam in Navy ships) to this known carcinogen. Although asbestos exposure causes a specific type of lung cancer, mesothelioma, the coding for this was not distinct until 1997 and some early mesothelioma cases would have been coded as lung cancer.

Lung cancer may also be a manifestation of exposure to the herbicides that were used in Vietnam. The recent review by the National Academy of Sciences lists lung cancer as a cancer for which there is limited or suggestive evidence of an association with herbicide exposure.[40] Perhaps this also contributed to the elevation in lung cancer mortality.

In the recently completed cancer incidence study, an analysis by histological type was undertaken.[37] This showed that Australian Vietnam veterans developed proportionally more adenocarcinoma of the lung. In Australia, histological data on cancer are not usually recorded on death certificates, so this study was unable to make observations about the histological type responsible for the increase in mortality.

In summary, Australian veterans have increased mortality from lung cancer, and this is consistent with observations made in the recent cancer incidence study.

7.6.2 Head and Neck Cancer

This group of malignancies comprises malignancies arising from the upper aero-digestive tract – the pharynx and hypopharynx, but it does not include cancers of the skin covering the head, and does not include brain tumours.

The incidence of these tumours was found to be elevated in this cohort of veterans.[37] In Australia less than half of those who develop cancer of the head and neck die from this condition.[41] In this study a significant increase in the mortality from this tumour was observed, with an SMR 1.44 (95% CI 1.16, 1.73).

There are a number of established causes for cancer of the head and neck. One of these is cigarette smoking. If the rate of cigarette smoking was elevated in this cohort, this could explain some of the increase in this group of tumours.

Alcohol is also a known risk factor for this group of tumours.[42] There is evidence that Australian Vietnam veterans have a higher level of alcohol consumption than the general population,[28] and perhaps this contributes to the elevated mortality from this condition.

Lastly, some have suggested that exposure to herbicides, which were used widely during the Vietnam war may increase risk of respiratory tract cancer.[40]

Australian Vietnam veterans appear to develop and die from cancer of the head and neck at a rate higher than the general population.

7.6.3 Melanoma

Melanoma is a neoplasm of the skin that arises from the melanocytes contained within the skin. Australia has one of the highest incidence of this tumour in the world, however survival rates are continuing to improve.[43]

In this study, we found that the rate of death from melanoma in Vietnam veterans did not differ significantly from the rate found in the general community, except within the Navy cohort. In the first study in this series, the cancer incidence study, it was found that Australian veterans of the Vietnam War have an elevated incidence of melanoma.[37] The higher incidence with a non-elevated mortality would suggest early diagnosis and appropriate management of this cancer within the veteran population. However amongst Navy veterans incidence and mortality remain elevated.

7.6.4 Hodgkin's Disease

In Australia, Hodgkin's disease is a malignancy with a good and improving prognosis, with a five-year survival of 73.8% between 1982 and 1986, rising to 84.4% between 1992 and 1997.[43] In the cancer incidence study[37], a significant elevation in the incidence of this disease was noted, with a SIR of 2.05 (95% CI 1.49, 2.61). However, this study found that the mortality from this condition did not differ from the community expectation.

There are possible explanations for this observation. Perhaps Australia veterans are accessing better health care, or are more vigilant for the early signs of cancer than the average Australian male. Or perhaps the excess of Hodgkin's disease is composed of non-aggressive tumours that are amenable to treatment.

It is encouraging that although two of the cancers of *a priori* interest have a higher incidence among Vietnam veterans compared to the Australian community, that is melanoma and Hodgkin's disease, the mortality rates from these cancers do not differ from that in the community. This suggests veterans are receiving early diagnosis and good management of these cancers.

7.6.5 Prostate Cancer

Prostate cancer was considered of *a priori* interest in this study because of exposure to herbicides. The most recently published review of this literature by the National Academy of Sciences reveals that this association amongst Vietnam veterans is based primarily on the results from this Australian cohort.[40] There is other evidence from occupationally exposed cohorts that suggests that exposure to herbicide increases risk of prostate cancer.[40] Against this, it should be noted that

the previous studies of Vietnam veterans were conducted when Vietnam veterans were much younger and prostate cancer was rare.

In this study there was a borderline significant elevation in the rate of death from prostate cancer, with an SMR 1.23 (95% CI 0.99, 1.46). In the cancer incidence study on this population there was an observed significant elevation in the incidence of this disease.[37] Furthermore, this increase can be attributed to elevated mortality in the most recent decade of follow-up, which showed a 29% statistically significant elevation. Thus, somewhat in contrast to melanoma and Hodgkin's disease discussed above, the observed increase in incidence seems to have resulted in a parallel increase in mortality from this disease.

7.6.6 Non-Hodgkin's Lymphoma

This malignancy was of *a priori* interest because of the possible association with herbicides.[40] In the recently completed cancer incidence study of this population, the incidence of non-Hodgkin's lymphoma was found to be significantly below the rate found in the Australian male population.[37] This study shows that mortality from non-Hodgkin's lymphoma was also significantly lower than expectation.

As was discussed in the Cancer Incidence Report,[37] it may be that there is some misclassification bias, with cases of non-Hodgkin's lymphoma being classified as a form of leukaemia or Hodgkin's disease. However this misclassification also would be expected to effect classification amongst the comparison group of the Australian community.

Indeed misclassification of non-Hodgkin's lymphoma was evident in a validation study of this disease.[44] When cases of leukaemia were further investigated into their four main types, it was found that some of these cases of leukaemia were in fact non-Hodgkin's lymphoma. The results of the validation study indicated that Vietnam veterans experienced a significantly higher than expected incidence of non-Hodgkin's lymphoma.

Another explanation for the observed results could be that this is an early effect of herbicide exposure and not detected in the cancer incidence study which began in 1982, and that the type of non-Hodgkin's lymphoma was not particularly aggressive and therefore not as apparent in a mortality study.

However, within the limitations of cancer incidence and mortality studies, the available evidence would suggest that Australian Vietnam veterans may be at a lower risk for this type of malignancy.

7.6.7 Connective and Soft Tissue Sarcoma

As with non-Hodgkin's lymphoma, this malignancy was of *a priori* interest because of the possible association with herbicides and their contaminants. The incidence and mortality from this tumour is relatively rare. In this cohort, based on 12 deaths, an SMR was observed that did not differ from expectation, 0.75 (95% CI 0.38, 1.28).

Earlier studies of American Vietnam veterans had detected an elevation in mortality from soft tissue sarcoma,[45] but the Australian veterans do not appear to experiencing this condition at a rate different to the population.

7.6.8 Multiple Myeloma

Multiple myeloma is a relatively rare tumour and occurs predominantly in those over the age of 40. This tumour was of *a priori* interest because of limited or suggestive evidence of an association with dioxin exposure.[40] In this study, mortality from this disease suggested a non-significant lower than expected rate, although. However the incidence of this cancer was significantly lower than expected.[37]

7.6.9 Leukaemia

Leukaemia was of *a priori* interest due to evidence of an association between one form of leukaemia, chronic lymphocytic leukaemia, and dioxin exposure. There is inadequate or insufficient evidence of an association for the other forms of leukaemia.[40]

For this study, mortality data was available for the broad groups of lymphoid and myeloid leukaemias only and further differentiated into acute and chronic forms was not possible as in the cancer incidence study. Overall mortality from leukaemia did not differ from expectation among Vietnam veterans. Although there is a suggestion of elevated mortality for lymphoid leukaemia, this is not a statistically significant result, SMR 1.20 (95% CI 0.72, 1.67). However the incidence of this cancer was significantly higher than expected, due mainly to the chronic form.[37]

7.6.10 Gastrointestinal cancers

Gastrointestinal cancers were of *a priori* interest as they constitute a major group of cancers and previous studies indicated a possible higher than expected mortality from these tumours.[21] The cancers within this group include neoplasms of the oesophagus, stomach, large and small intestine, rectum and anus.

Mortality from this group of tumours or any of the individual tumours investigated in this group did not differ from expectation. In contrast, the Cancer Incidence Study[37] showed a significant elevation in the incidence of colon cancer amongst Vietnam veterans.

7.6.11 Other cancers

Bladder cancer

Smoking is an important risk factor for this cancer as are several organic chemicals associated with a variety of manufacturing processes. However the Institute of Medicine reported limited or suggestive evidence of *no* association between bladder cancer and dioxin exposure.[40]

In the present study, the mortality rate for bladder cancer was not significantly different from expectation. Based on 22 deaths, there was an SMR of 0.71, (95% CI 0.42, 1.01).

Brain cancer

Although this is a relatively rare cancer, a previous study indicated a higher than expected mortality among a subgroup of Vietnam veterans.[46] In this present study of all Vietnam veterans, the mortality from brain cancer did not differ from expectation.

Breast cancer

This cancer is rare among men but a previous study indicated a significant elevation in mortality.[21] In this study there were four deaths observed amongst Vietnam veterans and two were expected. This elevated mortality was not statistically significant nor was the incidence of breast cancer different from expectation.[37]

Liver cancer

Risk factors for liver cancer include hepatitis viral infection and cirrhosis of the liver.[47] The mortality rate from this cancer among Vietnam veterans although somewhat reduced, SMR = 0.88 (95% CI 0.63, 1.13) was not significantly different from expectation, however the incidence is significantly lower than expected.[37]

Thyroid cancer

Thyroid cancer was considered to be of *a priori* interest because some early reports had suggested that it may be associated with exposure to herbicides.[48] More recent reviews have not supported this view.[40] With only 2 deaths from this tumour, few meaningful observations can be made. The incidence for this cancer was significantly lower than expected.[37]

Testicular Cancer

Although this is a relatively common tumour, death from the tumour is rare, with a five-year survival rate in Australia greater than 95%.[43] With 14 deaths, the SMR for this tumour was close to expectation.

7.7 Other mortality

In addition to those diseases of *a priori* interest, the mortality from a number of other diseases or disease groups was investigated and is discussed below.

7.7.1 Genitourinary diseases

There was a significant decrease in the rate of death ascribed to this group of diseases, SMR 0.66 (95% CI 0.42, 0.90). Individual causes of death within this group were not investigated because of small numbers but a reduction in the rate of death from renal disease, the main condition in this group, is likely to explain the decrease observed.

There are plausible reasons for this group of veterans to have a decrease in the rate of death from renal disease. Several of the underlying conditions that result in renal disease, namely hypertension and diabetes, were conditions for which veterans were screened during recruitment. Thus renal disease would be expected to occur at a lower frequency than the general population.

7.7.2 Endocrine Disease and Diabetes Mellitus

For the entire group of Endocrine diseases, there was a significant decrease in the rate of death. This was driven by a significant decrease in the rate of death for diabetes mellitus, which accounted for over half the deaths in this group, SMR 0.52 (95% CI 0.38, 0.66).

Deaths due to diabetes in this age group will mainly relate to deaths from juvenile onset or Type 1 diabetes mellitus with deaths from Type 2 diabetes generally occurring at older ages. By the time of service in Vietnam, most Type 1 diabetics would have developed overt disease. This was an absolute bar to service in Vietnam. Thus, there would have been no Type 1 diabetics sent to Vietnam, while all would be found in the residual population, creating a selection bias, which today manifests itself by a decrease in death for this condition and the Endocrine Disease group.

The decrease in the rate of death from diabetes can provide little insight into the prevalence of Type 2 diabetes mellitus, which is a much more common disease among people of the veterans' age group.

Although a recent review from the National Academy of Sciences has suggested that exposure to herbicides may give rise to an increased risk of Type 2 diabetes mellitus,[40] any increased mortality from this is likely to be found in the future, and it may never overcome the effect of excluding the Type 1 diabetics at the selection of the cohort.

7.7.3 Peptic Ulcer Disease

There were 12 deaths from peptic ulcers whereas 23 would have been expected from Australian standardised data. This is a statistically significant decrease in the rate of death from this disease, with an SMR of 0.55 (95%CI 0.27, 0.93). Seltzer and Jahlon observed a similar decrease in mortality from peptic ulcer disease among WWII veterans, with an SMR of 0.50.[11]

This decrease in mortality from peptic ulcer disease is somewhat surprising. There are several known causes of peptic ulcer disease. *Heliocobactor pylori* and

non-steroidal anti-inflammatory drugs are often considered to be the most important risk factors,[49] although some authors continue to see stress as a factor in the aetiology of this disease.[50] Possible explanations for lower than expected mortality from peptic ulcer disease could be that the consumption of the anti-infective, Dapsone, reduced the rate of infection with *H. pylori* or perhaps this cohort had less skeletal-muscular problems and consumed lower levels of non-steroidal anti-inflammatory drugs.

7.7.4 Multiple Sclerosis (MS)

Although this disease is more common than MND, it has a much longer period between the onset of the disease and death from the disease. Thus, in contrast to MND, mortality studies are not the preferred methodology for examining this disease within a cohort.

As with MND, this disease has been the subject of a validation study[29] in response to the high frequency of self-report of this illness in the morbidity study.[51] The validation study found that under all of the models used, the rate of MS did not differ from broader community rates. In this mortality study, based on small numbers (5 observed deaths, with 8 expected) the rate did not differ from that which would be expected.

7.7.5 Mental and Behavioural Disorders

Based on 51 deaths observed and 83 expected, there was a significant decrease in the mortality attributed to this group of diseases. Diseases in this group include dementia, mental retardation and childhood onset behavioural problems, all of which would not be expected amongst the Vietnam veteran cohort due to the age of the cohort or screening at time of enlistment.

Furthermore, this disease group is rarely used as a cause of death. The number of mental and behavioural diseases that give rise to death is small, and it does not reflect diseases such as depression, anxiety and PTSD. These conditions, while they cause very high levels of disability, are not usually reflected in death rates under this classification.

7.7.6 Assaults

Death as a result of assault was about half of that found in the general community. Based on 31 deaths observed and 55 expected, a significant reduction in the rate of death as a result of assault was observed. Perhaps military training is protective for this cause of death.

7.7.7 Diseases of the Skin, Eyes and Ear

These groups of diseases do not include melanoma and other forms of skin cancer. The diseases that are included within this group are diseases that rarely result in death, although they cause extensive morbidity and disability. Mortality studies

are not a good method of measuring disease for these conditions. Based on few observed deaths, few meaningful observations can be made.

7.7.8 Congenital Abnormalities

There was a profound decrease in the number of deaths from congenital abnormalities. With only six deaths observed and 25 expected, the rate of death from this group was only a quarter of that found in the general male population. This is a reflection of the strong selection bias within the construction of the cohort.

7.8 Mortality by Branch of Service

Of the three services deployed to Vietnam, the RAAF was by far the smallest, with only about four and a half thousand veterans, compared to thirteen and a half thousand RAN veterans and more than forty-one thousand Army veterans. This means that the study has least power to make observations about the RAAF veterans, and that the confidence intervals for specific diseases are likely to be wider for the RAAF. Conversely, this study has the greatest power to make observations about the Army veterans; here the confidence intervals are likely to be narrower. The RAN cohort lies between the Army cohort and the RAAF cohort in terms of power to make observations.

Despite the varying power for the subgroups of veterans, some observations can be made on the mortality experience of the three branches of service. Mortality among the RAN veterans does not differ from the Australian population. Conversely, both the Army cohort, and to a greater degree, the RAAF cohort, showed a significantly lower mortality when compared to the general population.

In addition, only the RAN veterans exhibited a significant elevation in overall mortality for a major cause of death, that is, mortality from neoplasms. This pattern of relatively high mortality from neoplasms in RAN veterans has also been observed in a study of Australian veterans of the Korean War.[17]

There needs to be some reservations expressed about the interpretation of mortality results by branch of service. Several sub-groups and many individuals spent varying amounts of their time serving with another Service or in an environment different from that experienced by the majority in that branch. As an example, RAN helicopter pilots served in-country, mostly with RAAF, but also with the Army. Conversely, the Army's Small Ship Squadron spent much of their time in Vietnam in ships on estuarine and marine water.

Nonetheless, this study does suggest that there are differences in mortality between the three services.

7.9 Summary

This was a retrospective mortality study of Australia's veterans of the Vietnam War. This study has both strengths and limitations. The strengths include the size of the cohort and the completeness of vital status ascertained. Limitations include the strong healthy worker or healthy soldier effect in comparing this cohort with the Australian population and the lack of specific exposure data during Vietnam service. In addition, there are a number of diseases that can cause significant morbidity and ill health which are not assessed by a mortality study.

Overall, Australia's veterans of the Vietnam War display lower mortality than the Australian community. The reduction is evident particularly in the earlier periods and is not present in the most recent period studied. The overall lower mortality amongst Australia's veterans of the Vietnam War is a manifestation of the healthy worker effect, which includes, among other factors, the effect of the selection of men who were fit at the time of service. Specifically lower mortality compared to the Australian population was observed for infectious diseases, endocrine diseases, diseases of the circulatory, respiratory and nervous systems. Death from mental disorders and congenital malformations were also lower than expected. No single major cause of death analysed was significantly higher than expected for both Scenarios. However, Vietnam veterans exhibited a mortality rate from neoplasms and alcoholic liver disease, which was significantly elevated in Scenario 1.

Taken together with the Cancer Incidence Study[37], there were several cancers for which both the incidence and mortality were higher than expected. These include lung cancer, cancers of the oral cavity and head and neck and in more recent times prostate cancer. There were also several cancers for which incidence was higher than expected but mortality was within expectation. These include colon cancer, cancers of the genitourinary system, melanoma and Hodgkin's disease. The prognosis for several of these cancers improves substantially with early diagnosis and treatment. The discordance between incidence and mortality could be related to health service use among the veteran population. Finally there was one cancer, non-Hodgkin's lymphoma, for which both mortality and incidence were possibly lower than expected.

Mortality varied between the Service branches with Navy veterans having the highest mortality level, although with the exception of mortality from neoplasms, mortality was within or below expectation. Navy personnel had significantly higher than expected mortality from all neoplasms, lung cancer, melanoma and mesothelioma but a lower than expected mortality form non-Hodgkin's lymphoma. Army personnel had a higher than expected cancer mortality from eye cancer, cancer of the oral cavity and head and neck and a borderline significant elevation in lung cancer. RAAF personnel revealed a non-significant elevation in mortality from lymphoid leukaemia and a significant decrease in mortality due to stomach cancer.

This study provides contradictory results for causes of death of *a priori* interest and/or associated with herbicide exposure. Many did not differ from expectation,

some were possibly significantly lower than expectation (non-Hodgkin's lymphoma) and others displayed rates that were higher than expected (lung cancer and head and neck cancer and in more recent times prostate cancer).

Although the healthy worker effect seems to strongly influence the results of this study, this influence is becoming less evident over time. There is a trend for increasing mortality from neoplasms, digestive diseases and suicide as the population ages and the latency period decreases.

In conclusion, most military cohorts display a mortality rate below that of the general community and after more than 30 years of follow-up Australian Vietnam veterans also display a lower than expected overall mortality rate. However the manifestation of this healthy worker effect is diminishing over time.

The third volume in this series, *Australian National Service Vietnam Veterans: Mortality and Cancer Incidence 2005*, compares National Servicemen who served in Vietnam to those who served in Australia and thus controls for the healthy worker effect.

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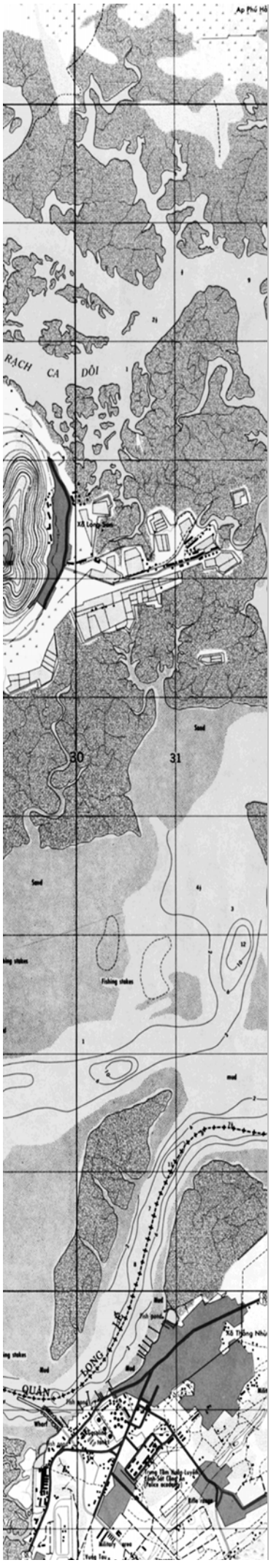

Literature Review of Health Effects of Vietnam Service

Appendix A Literature Review of Health Effects of Vietnam Service

The following literature review for the *Third Vietnam Veterans Mortality Study* and *Cancer Incidence in Vietnam Veterans Study* was compiled in 2002 and was presented to the Scientific Advisory Committee meeting in December 2002.

Glossary

AIHW	Australian Institute of Health and Welfare
AVH	Australian Veteran Health study, 1984
95% CI	95% confidence interval
COPD	Chronic obstructive pulmonary disease
ESOs	Ex-service organisations
GI	Gastrointestinal tract
ICD-10	International Classification of Diseases (10^{th} Ed)
MND	Motor neurone disease
MS	Multiple sclerosis
OR	Odds ratio
PMR	Proportional mortality rate
PTSD	Post-traumatic stress disorder
RAE	Royal Australian Engineers
RR	Relative rate
SIR	Standardised incidence ratio
SMR	Standardised mortality ratio
VAO	Veterans and Agent Orange report
VVMS	Vietnam Veterans Mortality Study, 1997

Literature Review of Health Effects of Vietnam Service

A.1. Introduction

Australian Defence Force personnel participated in the Vietnam Conflict from 1962 to July 1973. This was the most significant military commitment of Australian Forces since World War II, involving nearly 60,000 personnel of whom just over 500 were killed in action and 3,131 were severely physically wounded.

Since the Vietnam conflict, Ex-Service Organisations (ESOs) have maintained that Vietnam service adversely affected the health of veterans. Initial studies into the health of veterans showed no excess risk attributed to their service when compared with the Australian population or national service personnel who served in Australia. However more recent studies have shown that Vietnam veterans have excess incidence and mortality rates from several conditions, such as cancers and heart disease, compared with the Australian population and non-veteran counterparts.

Service during the Vietnam conflict presented distinctive health challenges. The nature of the conflict meant that troops were under combat-like conditions for extended periods. Herbicides and pesticides were used extensively during the conflict. The most notorious of these was Agent Orange, contaminated with 2,3,7,8-tetrachlorodibenzo-*p*-dioxin, a known toxic agent. Other chemicals were used in Vietnam such as other herbicides (paraquat), pesticides (picloram and DDT), anti-malarial drugs (dapsone) and solvents (toluene).

Many studies have been done on Vietnam veterans to ascertain the physical and mental health consequences of their service during the Vietnam conflict. In addition, environmental and occupational studies on the toxic effects of chemicals of interest have been useful in assessing health risks of Vietnam service.

This paper reviews selected literature of relevance to the mortality and cancer incidence of male Australian Vietnam veterans. Section 2 provides a detailed review of Australian studies on the health effects of Vietnam service. Section 3 reviews the literature in relation to specific categories of illness using the International Classification of Disease, tenth revision (ICD-10).

A.2. Studies of Australian Vietnam veterans

Numerous studies on the health of Australian Vietnam veterans have been published since the Vietnam conflict. The Australian government has commissioned many of these studies. The table at the end of this review lists the government studies and peer-reviewed published papers on Australian Vietnam

veterans. Reports commissioned by the government are listed in quotation marks. The following section details the results from the main Australian studies.

A.2.1. Australian Veterans Health Study (AVH)

In 1980 the Australian government commissioned the Commonwealth Institute of Health (now known as the Australian Institute of Health and Welfare, AIHW) to conduct a series of studies into the health of Vietnam veterans and their families. A retrospective cohort mortality study of 46,166 Australian national servicemen, the Australian Veterans Health Studies (AVH), was completed in 1984.[1] The study compared the mortality of national service veterans who served in Vietnam to national service personnel who remained in Australia. This study found no significant increase in mortality among veterans compared to non-veterans. Both veterans and non-veterans had significantly lower mortality rates than expected for a similar aged cohort of Australian males.

A factor that may have influenced the results of this study is the healthy worker effect.[2] Military personnel are screened at recruitment and are generally fitter than the Australian population. Personnel with diseases from congenital anomalies, mental disorders, and endocrine, nutritional and metabolic diseases are ruled out in the screening process. The healthy worker effect lasts for many years after service and it is not clear what the magnitude of this effect may be over time. [3, 4]

The AVH study further analysed death rates of veterans and non-veterans by Corps grouping. The Royal Australian Engineers (RAE) veterans had a statistically significant higher death rate compared to non-veterans, SMR = 2.5, (95% confidence interval (95% CI) 1.4, 4.0). However among veterans there was no significant variation between Corps groupings, although the RAE had the highest death rate. Analysis of cause of death determined that the elevation in death rate among RAE was due to death from external causes such as motor vehicle accidents.

No increased mortality due to neoplasms was observed for Vietnam veterans compared with non-veterans or the Australian population. However the follow-up of a maximum of 16 years was relatively short for meaningful conclusions about neoplasms.

A.2.2. Dapsone exposure, Vietnam service and cancer incidence study

Dapsone was an anti-malarial drug used by Army and land based Navy personnel serving in Vietnam from 1968 through 1972. The Australian Institute of Health and Welfare (AIHW) examined the relationship between dapsone exposure, Vietnam service and cancer incidence among 155,407 Australian Army personnel.[5] Dapsone had been shown to be associated with toxicity on white blood cells and other adverse reactions, such as haemolytic anaemia and peripheral neuropathy. Concerns were also raised about the possible carcinogenicity of this drug. The study compared cancer incidence among Regular Army and national service veterans and non-veterans and also correlated cancer incidence with lifetime dose of dapsone received. The study concluded

that there was no definite evidence for an association between dapsone exposure and overall cancer incidence. Nor was there definite evidence of association between Vietnam service and overall cancer incidence.

However the study did describe a statistically significant increase in pancreatic, lung, and brain cancers among national service veterans compared to national service non-veterans. This association was not seen among all veterans or Regular Army veterans. As 29 different cancer sites were tested for significant association, the authors reasoned that the three cancers showing increased rates could be a statistical anomaly. In addition, the authors concluded that given the follow-up period was at most 24 years, it was too early to expect a significant increase in rates of solid cancers.

A.2.3. Vietnam Veteran Mortality Study (VVMS)

A second Vietnam veteran mortality study was completed in 1997.[4] This study compiled a comprehensive Nominal Roll of all Vietnam veterans, including civilians, medical personnel, entertainers, and female veterans. The mortality rate for all male military personnel and individual service branches was compared to the mortality rate for the male Australian population. Not all deaths among Vietnam veterans could be identified within the databases used for the study. This resulted in an underestimation of the observed deaths and consequently would lead to an underestimation of the SMR. Thus the results reported were adjusted for under-ascertainment based on the proportion of deaths found on the National Death Index and the DVA client database.

The centralised registry of death in Australia, the National Death Index, was begun in 1980. To accommodate the different data completeness, analysis was divided into two periods: 1964 to 1979 (prior to the start of the NDI) and 1980 to 1994 (after the start of the NDI). The standardised mortality rate for all military personnel prior to 1980 was significantly lower than the Australian population, SMR = 0.68, (95% CI 0.63, 0.74), whereas after 1980 the mortality rate was significantly higher, SMR = 1.07, (95% CI 1.02, 1.12). There was statistically significant increased mortality for all neoplasms, ischaemic heart disease, and suicide. The significant increase in neoplasms was attributed to elevated rates of prostate and lung cancers, cancers of the tongue, 'other' digestive organs, and male breast, although the latter was due to only three cases.

Of the three service branches, Navy veterans had the highest overall mortality, SMR = 1.37 (95% CI 1.23, 1.52) and mortality for all neoplasms, SMR = 1.58 (95% CI 1.31, 1.89). Navy veterans also had significantly increased mortality due to diseases of the circulatory system, SMR = 1.26 (95% CI 1.04, 1.52) and external causes, SMR = 1.48 (95% CI 1.15, 1.86).

This study also investigated mortality rates by service branch, Corps grouping, days served in Vietnam, number of tours or visits, and calendar year first in Vietnam. The Army Corps groupings were those used in the AVH study which had applied expert opinion to classify the groups according to the stress and danger to which the men were exposed. The SMRs between the Army Corps groupings were not statistically significantly different. The elevated SMR for

Navy was due to increased mortality among logistic support personnel. However this group accounted for 86% of all Navy veterans. SMRs for Air Force were not statistically different between squadrons or units. The results for the other exposure measures were inconsistent across the categories and the authors concluded that the apparently statistically significant trends were likely to be due to chance alone.

In addition, the effects of latency, (the time between exposure and manifestation of disease/death due to that exposure) were investigated. If exposure was associated with increased mortality from solid tumours, which have a latency of twenty or more years, then the SMRs would be expected to increase with increasing time since exposure. This trend was only observed for Navy veterans among whom a significantly increasing trend of cancer death was seen with increasing time since exposure.

A.2.4. Mortality of National Service Vietnam Veterans study

A supplementary study to the Vietnam Veteran Mortality study was undertaken to examine mortality among national servicemen veterans and non-veterans.[6] This analysis eliminated the healthy worker effect inherent to comparing a military population with the general Australian population. It also extended the Australian Veteran Health studies with an additional 13 years of death data. The total length of follow-up was 22 to 29 years.

The National Service study analysed the mortality of 43,595 national servicemen, 18,949 veterans and 24,646 non-veterans, serving during the Vietnam Conflict years between June 1965 through February 1971. The smaller size of the cohort than in the AVH study was in large part due to excluding servicemen who served less than one year in the Army whereas the AVH study included personnel who served greater than 90 days.

Mortality from all causes was significantly higher in national service veterans RR = 1.15 (1.00, 1.33). Death from all cancers was elevated but not significantly. The lung cancer rate was twice that among non-veterans, RR = 2.2 (1.1, 4.3) and cirrhosis of the liver nearly triple, RR = 2.7 (1.22, 6.4). Brain cancer was also significantly elevated, RR = 5.6 (1.53 > 10), based on three cases.

In contrast to the AVH study, the study did not find any effect of corps groupings, either within or between national service veterans and non-veterans.

A.2.5. The Australian Vietnam Veterans Health Study

O'Toole *et al* conducted the Australian Vietnam Veterans Health Study involving a random sample of 1000 Army veterans whose service ceased more than 20 years prior to the study.[7-9] Physical and mental health in relation to combat exposure was assessed using Army records, personal interviews and questionnaires. The veteran sample of 641 respondents reported greater health service usage and an excess of health problems compared to community norms. Reports of most chronic conditions were elevated with a statistically significant relative risk of greater than four for infective and parasitic diseases, neoplasms, 'other'

endocrine disorders, mental disorders, haemorrhoids, bronchitis or emphysema, skin rashes, and injury. The results were based on self-reported conditions and no validation studies were performed.

A.2.6. Morbidity of Vietnam Veterans studies

A series of studies assessing the morbidity of Vietnam veterans was begun in 1996. A self-completed health questionnaire was distributed to 49,944 male veterans[10] and 278 female veterans[11]. Greater than 80% of the veterans contacted completed the survey. The questionnaire asked veterans to assess their own health, and provide details of their marital status, health of their partner, and their children.

The results of the survey were compared with expected community norms obtained from several surveys including the 1995 National Health Survey conducted by the Australian Bureau of Statistics[12]. The comparisons suggested that the health of Vietnam veterans and their families was worse than that of the Australian population. A series of validation studies were undertaken to assess the reported elevated rates of illness. The number of validated cases of melanoma and cancer of the prostate were significantly higher than expected.[13] There were 483 validated cases of melanoma and 380 were expected using community norms, (95% CI 342, 418). For cancers of the prostate, 212 cases were validated and 147 expected (95% CI 123, 173). However significantly fewer lung cancers, soft tissue sarcomas, and cancers of the testis were observed than expected. For lung cancer, the authors noted that the fewer than expected cases was probably an artefact due to a number of veterans having died from lung cancer and consequently having been missed by the morbidity study. The number of confirmed cases of leukaemia was within expected range but non-Hodgkin's lymphoma was elevated, with 66 validated cases, 48 expected (95% CI 34, 62).[14]

The rare conditions of multiple sclerosis (MS) and motor neurone disease (MND) were validated among respondents to the morbidity questionnaire.[15] Based on clinical notes and death certificates, 20 cases of MS were validated among Vietnam veterans while 17cases were expected, (95% CI 9, 26). Three cases of MND were validated, compared to 1.2 expected, (95% CI 0, 3.3). This is the upper limit of significance for the expected number of cases of MND. While the validation study was taking place one more validated case of MND and two probable cases developed in Vietnam veterans who did not participate in the original Morbidity survey.

A.2.6.1 Health of Vietnam veterans' children

The incidence of several conditions was elevated among the children of Vietnam veterans. The rates of cleft palate and spina bifida maxima were significantly higher in veterans' children than expected.[12] Suicide among children of Vietnam veterans was three times more common than expected.[16] Ten cases of the rare condition of adrenal gland cancer were validated when no more than three were expected.[14] Thirteen cases of acute myeloid leukaemia (AML)were validated and three expected, (95% CI 0, 6).

A.2.7. Other studies

A.2.7.1 Reproductive health

Studies on reproductive health and congenital anomalies have reported equivocal results, though recent studies point to increased health problems in veterans' children. An early study by Donovan *et al* [17] found no correlation with Vietnam service and birth anomalies when investigating 8,517 case-control pairs of children. This study investigated defects evident only at birth and had sufficient power to detect an increase only for overall defects and not any single type of defect. Field *et al* [18] reported greater foetal loss, more stillbirths and more deaths of offspring as well as an increase in chronic health problems in children of 436 Tasmanian veterans compared to nominated neighbour 'controls'. However, the validity of this study was called into question by the Evatt Commission on methodological grounds relating to sampling and respondent bias.[19] Finally the validated Morbidity Study discussed in the previous subsection[14, 16] showed an increase in suicide, spina bifida maxima, cleft lip and palate, adrenal gland cancer and acute myeloid leukaemia in children of veterans.

A.2.7.2 Psycho-social health of Vietnam veterans

Numerous studies have been done on the psycho-social effects of military service during the Vietnam conflict.[7, 20-27] Although conditions such as post-traumatic stress disorder (PTSD), substance abuse, and depression can have severe adverse effects on physical health, these conditions will not be discussed further in this review which focuses on studies of mortality and physical morbidity.

A.2.8. Summary of results of Australian studies

Early studies on the health of Vietnam veterans were hindered by the presence of the 'healthy worker effect' in comparing veteran health to community norms. Other studies have overcome this bias by comparing Vietnam veterans with non-veterans who served in Australia during the conflict years. With increasing latency from the time of service, more health problems among Vietnam veterans are becoming evident.

Several mortality studies[4, 6] have shown an increase in the rate of neoplasms, particularly lung, prostate, and tongue cancers among Vietnam veterans. However the rate of lung cancer was not shown to be elevated in a morbidity study[13] although rates of melanoma and prostate cancers were higher than expected. Increased morbidity and mortality from cirrhosis of the liver was also demonstrated.

Efforts to correlate exposure to illness have been inconclusive. Length of time in Vietnam, calendar year of service, location of service, corps grouping, and service branch have not shown any consistent trend across perceived exposure gradients. Navy personnel who were thought to have the lowest exposure to the chemical hazards of the Vietnam mainland had the highest mortality rate in the 1997 study. Assessment of morbidity and mortality trends for Vietnam veterans is also

hampered by lack of information on known individual risk factors for ill health such as smoking, alcohol misuse, and obesity.

In conclusion the studies on Australian Vietnam veterans indicate that significant health issues may be attributable to their Vietnam service. Long-term health problems are becoming more apparent with increasing years from the conflict and warrant continued monitoring.

A.3. Health effects of Vietnam service by ICD-10 Chapter

This section reports the findings of Australian, American and other international studies on the health effects of Vietnam service by disease category as classified by ICD-10 code. The studies of the health of Vietnam veterans have tended to investigate mortality or morbidity associated with two general exposures; either Vietnam service itself or exposure to Agent Orange during Vietnam service. For example, major American studies have investigated the effect of dioxin exposure among Ranch Hand Air Force personnel, the unit involved in spraying Agent Orange in Vietnam.

For Vietnam veterans who were not in the Ranch Hand program, it is difficult to reconstruct exposure to Agent Orange. To assess the health effects of potential exposure to herbicides and pesticides experienced by Vietnam service, studies of occupational exposure (chemical and agricultural workers) to dioxin and other herbicides or pesticides and environmental studies, such as survivors of the Seveso, Italy industrial accident, are also reported. The 'Seveso accident' occurred in 1976 at a small Italian chemical plant. The exposed population has been extensively studied and has contributed to the understanding of the human health effects of dioxin.

Information on dioxin exposures draws extensively from the 2002 update of the Institute of Medicine publication *Veterans and Agent Orange* (VAO).[28] This report, first published in 1994, is an extensive literature review which is updated every two years and concerned with the health effects of Agent Orange exposure among Vietnam veterans. This report categorises the association between specific health outcomes and exposure to herbicide into four groups: conditions with sufficient evidence of an association, conditions with limited/suggestive evidence, conditions with inadequate/insufficient evidence, and conditions with limited/suggestive evidence of *no* association. These categories are based on statistical association reported in the literature not on causality. The strength of the reported association is assessed on the quality of the study and the extent to which chance, bias, and confounding were addressed.

A.3.1. Chapter I Infectious and parasitic diseases (A00-B99)

Many infectious and parasitic diseases are endemic to South East Asia and Australian troops may have contracted these diseases while serving during the conflict. Approximately 250,000 American Vietnam veterans contracted cerebral malaria which can have long-term neuropsychiatric symptoms.[29] Australian

veterans' burden of malaria involved less than 1,000 personnel out of over 40,000 Army veterans.[5]

Melioidosis is caused by a soil bacterium endemic in Vietnam and often found in rice paddies. The organism frequently infects the lung causing a variety of non-specific symptoms and can remain latent for years. Two case reports of reactivated Melioidosis have been described in US Vietnam veterans, seven and eighteen years after Vietnam service.[30, 31]

Strongyloidiasis, an unusual nematode infection (*Strongyloides stercoralis)*, has been described in 1.6 percent of a sample of American Vietnam veterans.[32] Three veterans with chronic infection have been reported[33] and a fatal re-activation in an immunosuppressed patient.[34]

Hepatitis B infection is endemic in Vietnam. The incidence of hepatitis B infection among US Vietnam veterans has been calculated to be 0.6-4.0 cases per 100 soldier years[35] and veterans were more likely to be infected than non-veterans. Chronic hepatitis C infection is also common among veterans[36, 37] Many veterans with hepatitis C may also have co-morbidity of psychiatric disorders.[38] Chronic hepatitis infection is a major risk factor for heptocellular carcinoma.

In conclusion, infectious and parasitic diseases contracted during Vietnam service may have long term health consequences for some veterans.

A.3.2. Chapter II Neoplasms (C00-D48)

Neoplasm mortality is a concern for Vietnam veterans. Many studies have shown an association between dioxin exposure and increased rate of neoplasms and this is becoming more evident with increasing time from Vietnam service. These and other studies are detailed below.

A.3.2.1 Gastrointestinal tract cancers (C16-C21, C26)

This group of cancers include stomach, colorectal and pancreatic cancer. Colorectal is the second most frequently occurring cancer among Australian males (66.7 cases per 100,000 per year) whereas stomach and pancreatic cancers are much less common, (13.3 and 9.3 cases per 100,000 per year, respectively).[39]

An American proportionate mortality study demonstrated an increased mortality from pancreatic cancer among Marine personnel, PMR = 1.11 (95% CI 1.02, 2.05) but not among Army (PMR = 1.00).[40]

The 1997 VVMS showed an elevated but not significant increase in gastrointestinal cancers, except for the category 'other digestive organs', with a SMR of 2.41 (1.04, 4.74), based on 8 deaths. However among Navy personnel two GI cancers had a significantly elevated mortality; colon cancer (18 deaths) SMR = 1.76 (1.03, 2.81) and other digestive organs SMR = 5.52 (1.14, 16.11), based on three deaths. In the most recent Australian study, the Validation Study, no excess risk for colorectal cancer was noted among Army veterans.[13]

The 20 year follow-up of Seveso residents showed an elevated mortality from rectal cancer, RR = 1.8 (95% CI 1.0, 3.3).[41] Schreinemachers[42] also showed an association between increasing herbicide exposure and increased mortality from stomach, rectal and pancreatic cancers in US agricultural areas using a surrogate exposure of wheat acreage (more than 90% of spring wheat is treated with chlorophenoxy herbicides).

The 2000 update of VAO concluded limited/suggestive evidence of *no* association between herbicide exposure and gastrointestinal tract cancers (stomach, colon, rectum and pancreas).[28]

A.3.2.2 Hepatobiliary cancers (C22-C24)

Hepatobiliary cancer, consisting of cancer of the liver and hepatobiliary duct, is a rare neoplasm affecting 4.6 males per 100,000 Australians per year.[39]

The Australian mortality study, VVMS, found no increased mortality for hepatobiliary cancers among military veterans The American Ranch Hand study found a non-significant elevation in liver cancer in the high-dioxin category but this was based on only two cases. However when adjusting for covariates a marginally positive association between herbicide exposure and liver cancer was noted, RR = 2.5 (95% CI 1.0, 6.2).

Despite the suggestion of an increased risk for liver cancer, the VAO concluded that there was inadequate/insufficient evidence of an association with herbicide exposure. Confounding by lifestyle factors for this rare class of cancers make interpretations of studies difficult.

A.3.2.3 Head and neck cancer (C01-C14)

Head and neck cancers comprise cancers of the lip, oral cavity and pharynx and affect 12.4/100,000 Australian males each year.

The VVMS found a significantly elevated mortality rate for cancer of the tongue, SMR = 2.53 (95% CI 1.47, 4.05) among all military personnel compared to the Australian population. Non-significantly elevated mortality rates were also observed for gum and mouth, oro/hypopharynx and other lip and oral cavity cancers. The rates for these cancers were highest among Navy veterans.[4] There was no significantly elevated mortality for these cancers among national service veterans when compared with non-veterans.[6]

No significantly elevated incidence of oral cavity or pharyngeal cancers was observed among the Ranch Hand veterans.[43] The 2000 update of the VAO found inadequate/insufficient evidence for association with nasal and nasopharyngeal cancers (C11, C30).[28] The results from different studies are, however, not always comparable as each study may group the cancers within this category differently

A.3.2.4 Laryngeal cancer (C32)

Cancer of the larynx affects 5.9/100,000 Australian males per year.[39] The VVMS found an elevated but non-significant increase in mortality for cancer of the larynx for all military veterans, SMR = 1.3 (0.67, 2.27).[4]

Steenland *et al*[44] reported an increased mortality from laryngeal cancer associated with occupational exposure of dioxin in US chemical workers, RR = 2.2 (1.1, 4.1).

The 2000 update of VAO found limited/suggestive evidence for an association with herbicide exposure and laryngeal cancer.[28] Laryngeal and head and neck cancers are also associated with excess drinking and smoking.[39] Therefore, it is difficult to differentiate the impact of lifestyle risk factors from herbicide exposure on the incidence of these cancers.

A.3.2.5 Lung cancer (C33, C34)

Lung cancer is the most common cancer among Australian males, occurring in 58.2/100,000 males every year. It is associated with smoking and mortality is high (SMR = 53.2/100,000/year).[39] Many studies do not have data on smoking habits of the cohort, which limits the interpretation of the findings.

The Australian VVMS found an increased mortality for lung cancer SMR = 1.29 (95% CI 1.12, 1.49) for all military personnel and SMR = 1.65 (95% CI 1.17, 2.25) among Navy personnel.

Watanabe *et al* [40] found a statistically significant increase in mortality from lung cancer in Army and Marine veterans compared to service specific non-veterans, PMR = 1.06 and 1.48, respectively. Analysis of lung cancer incidence among Ranch Hand Air Force veterans also showed a significant increase RR = 4.88 (95% CI 1.3, 17.8). When adjusting for co-variates this association remained elevated but was only marginally significant (RR = 3.7, p = 0.07).[43]

The 2000 update of the VAO concluded there was limited/ suggestive evidence for an association between herbicide exposure and lung cancer (however, their classification of lung cancer excluded cancer of trachea, ICD9 162.2).

A.3.2.6 Soft tissue and other sarcomas (C38.0, C45-C49)

Soft tissue sarcomas are rare cancers affecting less than 5 per 100,000 male Australians each year.

An early study of Massachusetts' Vietnam veterans showed an elevated risk of soft tissue sarcoma, SMR = 5.16 (95% CI 2.4, 11.1) compared to non-veteran military.[45] The total of nine deaths from soft tissue carcinoma reported in the VVMS was not significantly different from the number of expected based on rates in the Australian population, SMR = 1.00 (95% CI 0.46, 2.46).[4] Watanabe *et al* [40] also found no elevated mortality among American Army and Marine veterans,

PMR = 0.97 and 1.08, respectively. The Ranch Hand study has reported only one case of soft tissue sarcoma thus their analysis is limited.[43]

Studies of US chemical workers exposed to dioxin showed a significant increase in deaths from soft tissue sarcoma among workers with a greater than one year of service and 20 years or more since first exposure, SMR = 9.2; (95% CI 1.9 to 26.9).[46] Female Danish paper mill workers who were occupationally exposed to chlorinated organic pollutants, including dioxin, also experienced an increase in soft tissue sarcomas, SIR 3.98 (95% CI 1.71-7.84).[47] A study of residents near a waste incineration plant that was emitting high levels of dioxin in France demonstrated a spatial clustering of soft tissue sarcomas.[48] However Dutch and Finnish studies showed no association between dioxin exposure and soft tissue sarcoma.[49 50] Nor were there any deaths from soft tissue sarcoma among the exposed population in a 20 year follow-up of the Seveso accident.[41]

The VAO concluded that there was sufficient evidence for an association between herbicide exposure and soft tissue sarcoma mainly due to environmental and occupational studies. In general, studies of Vietnam veterans found too few deaths from these rare cancers for meaningful conclusions to be drawn concerning the incidence of soft tissue sarcoma in this population.

A.3.2.7 Melanoma (C43)

A major risk factor for melanoma is UV radiation. Northern areas of Australia have highest rate of melanoma in the world. A geographical analysis of the distribution of residency of Australian veterans shows a higher proportion of veterans live in Queensland, a high-risk area, than the proportionate Australian population.[4]

The Australian validation study showed a significantly increased risk of melanoma among Australian veterans, 483 cases validated, 380 expected, (95% CI 342, 418) but confounding assessment was not carried out.[13] The Ranch Hand studies found an increase in skin cancers but not melanoma.[43] There was also no increase in incidence of melanoma among Seveso exposed population, RR = 1.7 (95% CI 0.5, 5.3).[41]

The 2000 update of VAO concluded that there was inadequate/insufficient information to determine if there was an association between melanoma and herbicide exposure.

A.3.2.8 Prostate cancer (C61)

Prostate cancer is the most common cancer incidence among Australian males representing 23% of all new cancer cases with a lifetime risk of 1 in 11.[39]
The risk of contracting prostate cancer increases dramatically with age.

The Ranch Hand studies did not show any elevated risk for prostate cancer[43] but the Australian validation study[13] and 1997 mortality study[4] did show increase incidence and mortality for this cancer. The validation study found 212 cases of prostate cancer, compared to 147 (95% CI 123, 171) expected and the mortality

study showed a SMR of 1.53 (95% CI 1.07, 2.12). In a small study of 400 veterans with prostate cancer, Zafar *et al* [51] were not able to show any statistically significant association between self-reported Agent Orange exposure and prostate cancer. Among 400 veterans referred for prostate needle biopsy, 41% of veterans exposed to Agent Orange had prostate cancer compared to 34.4% of non-exposed veterans.

Risk of prostate cancer was significantly associated with herbicide use among a study of Canadian farmers.[52] This study was able to show a dose response between increasing herbicide exposure and increasing risk of prostate cancer. For the largest number of acres sprayed with herbicide the RR was 2.23 (1.30, 3.84). In a second study, US farmers also had an increased risk for prostate cancer, although use of herbicide in this study was not detailed.[53] Herbicide and pesticide exposure was also associated with an increased risk of prostate cancer in a population-based case-control study of occupation in the US.[54]

The 2000 update of VAO concluded that in light of the occupational studies there was limited/suggestive evidence for an association between exposure to herbicide and prostate cancer.[28]

A.3.2.9 Testicular cancer (C62)

Testicular cancer primarily affects men under 40 years of age. The death rate from this cancer is low (< 1.0/100,000/yr) thus the testicular cancer burden may not be captured in mortality studies.

In the Australian DVA morbidity study[10] veterans reported an increased incidence in testicular cancer but this was not sustained with the validation study. Fifty-nine cases of testicular cancer were confirmed whereas 110 (89-139) were expected.[13] The Ranch Hand study reported only three cases of testicular cancers among the exposed population,and the small number did not permit meaningful statistical analysis.[43] In addition, serum dioxin levels of Ranch Hand veterans were not associated with any testicular or gonadotropin abnormalities.[55] In a case-control study of American Vietnam veterans on the Agent Orange Registry, Navy personnel had a significant increase in testicular cancer, OR = 2.60 (95% CI 1.08, 6.24).[56]

An occupational study of pesticide workers in Florida demonstrated an elevated incidence of testicular cancer, SIR = 2.48 (95% CI 1.57, 3.72).[57] Other studies have also associated pesticide use with testicular cancer.[58, 59] However, little evidence exist for an association between herbicide use and testicular cancer in humans.

The VAO concluded there was inadequate/insufficient evidence for an association between testicular cancer and herbicide exposure.[28]

A.3.2.10 Bladder cancer (C67)

Bladder cancer is three times more common in males than females and has a high incidence but relatively low mortality rate in Australia. The rates in Australian males are 22.9 and 6.4/100,000/year, respectively.[39]

The studies of the association of Vietnam service with bladder cancer are equivocal. Ranch Hand studies combined kidney and bladder cancers for analysis and showed a significantly elevated risk for kidney and bladder cancer among low dioxin exposure category personnel, RR = 4.4 (95% CI 1.04, 18.95). Also the unadjusted risk assessment of all Ranch Hand personnel to comparisons was elevated, RR = 2.68 (95% CI 0.99, 7.28) but other statistical models tested showed no significantly elevated risk.[43] The Australian mortality study showed a non-significantly elevated mortality rate for bladder cancer for all military personnel, SMR = 1.10 (95% CI 0.55, 1.97) and higher but still non-significant risk among Navy, SMR = 1.26 (95% CI 0.15, 4.54).[4]

No increase in mortality from bladder cancer was noted among Seveso survivors, RR = 1.0 (0.4, 2.2)[41] and other environmental and occupational studies do not show a clear association between herbicide (dioxin) exposure and increased risk of bladder cancer. A study of American chemical workers exposed to high levels of dioxin showed no increase in mortality due to bladder cancer.[60]

Other chemical exposures have been associated with bladder cancer. For example, animal models have shown a significant increase in bladder cancer when exposed to arsenic compounds, a main component of Agent Blue, which was used extensively in Vietnam.[61-63] A meta-analysis of studies of US chemical workers showed a moderate association for excess bladder cancer incidence, meta-SIR = 2.21 (1.18, 4.15).[64]

The 2000 update VAO concluded there was limited/suggestive evidence of *no* association between herbicide exposure and bladder cancer.[28]

A.3.2.11 Non-Hodgkin's lymphoma (C82-C85, C96)

Non-Hodgkin's lymphoma (NHL) is diagnosed in 18.7/100,000 Australian males per year and 8.3/100,000 die from this disease every year.[39]

Studies of Vietnam service and risk of NHL generally point to an increase in this disease among veterans. A 1990 US study found a significantly increased risk for NHL among Vietnam veterans, OR = 1.47 (95% CI 1.1, 2.0) which was highest in Navy and blue water Navy personnel.[65] A US proportionate mortality study found an increased risk of NHL among Marine US veterans.[66] The Australian mortality study found a non-significant increase among military veterans, 1.04 (0.71, 1.46) but there were no cases among navy personnel.[4] In the 1999 Australian Morbidity Study the number of validated cases of NHL was at the upper limited of expected, 62 observed, 34-62 expected.[13]

Many occupational studies have shown an association with herbicide exposure and NHL for agricultural workers,[53, 67-70] and chemical workers.[71, 72] The 20 year

follow-up of the Seveso accident population showed an increase of NHL mortality, RR = 2.8 (95% CI 1.1, 7.0).[41]

Reviewing all the evidence, the VAO concluded there was sufficient evidence of an association with herbicide exposure and NHL.[28]

A.3.2.12 Hodgkin's disease (C81)

Hodgkin's disease is a relatively rare lymphoma with a high cure rate that commonly affects young adults and those over 55.

The data on Vietnam veterans are limited. The Ranch Hand studies had very few cases of Hodgkin's disease and analysis was limited but no significant increase risk was noted.[43] The Australian mortality study found a non-significant increased mortality among all military veterans SMR = 1.06 (0.34, 2.46).[4]

Analysis of the Seveso population showed a three-fold increase in Hodgkin's disease, RR = 3.1, (95% CI 1.1, 8.6). A British cohort of over 2000 chemical workers found no cases of Hodgkin's disease,[73] whereas in a cohort of 14,362 Danish paper mill workers a two-fold risk of this disease was reported, SIR = 2.01 (1.2, 3.2).[47] Increases were also noted in Irish and American agricultural workers.[74, 75]

VAO found there was sufficient evidence to conclude an association between herbicide exposure and Hodgkin's disease from environmental and occupational epidemiological studies.[28]

A.3.2.13 Multiple myeloma (C90)

Multiple myeloma is a disease of plasma cells in the blood and affects 6.3/100,000 male Australians every year.[39]

Australian Vietnam veteran studies found no significant difference in mortality from multiple myeloma with comparison groups.[4, 6] The most recent study of Ranch Hand personnel did not specifically report on multiple myeloma but grouped lymphoid and histocytic neoplasms which showed no increase in incidence.[43]

Occupational studies have shown an increase in multiple myeloma among agricultural workers.[67, 76, 77] A non-significant elevation of mortality from multiple myeloma was noted among residents of Seveso 20 years after the industrial accident.[41]

The VAO concluded that there is limited/suggestive evidence of an association between herbicide exposure and multiple myeloma. However mortality from this disease increases dramatically after the age of 45 so this cancer may still be of *a priori* interest.

A.3.2.14 Leukaemia (C91-C95)

There are four major types of leukaemia. Acute myeloid leukaemia (AML) accounts for approximately one quarter of leukaemia among adults. Acute lymphocytic leukaemia is more common in children. Chronic lymphocytic leukaemia (CLL) is the most common leukaemia and incidence increases with age. Chronic myeloid leukaemia (CML) incidence also increases with age. Overall leukaemia affects 18/100,000 male Australians per year.[39]

The VVMS did not demonstrate a significant association between Vietnam service and mortality from leukaemia, SMR = 1.26 (0.87, 1.78). The Australian validation study of a self-reported questionnaire showed no increased incidence of any of the four types of leukaemia in veterans, 23 cases validated, 26 expected (95% CI 16, 36).[13]

Residents of Seveso showed a significant increase in myeloid leukaemia after the dioxin accident, RR = 3.8 (95% CI 1.1, 12.5). Excess of leukaemia was noted in American and Dutch farm workers.[53, 78, 79] However in two of these studies the association was attributed to exposure to pesticides rather than herbicides.

There is limited data among Vietnam veterans. The 2000 update of VAO concluded there was inadequate/insufficient evidence to determine an association between herbicide use and leukaemia.

A.3.2.15 Conclusions for neoplasms (C00–D48)

The cancers for which the VAO studies have found sufficient evidence of an association with herbicide use include soft-tissue sarcoma, non-Hodgkin's lymphoma and Hodgkin's disease. The committee found limited/suggestive evidence for cancers of larynx, lung, bronchus (tracheae), prostate and multiple myeloma.

The Australian Vietnam veteran studies have found statistically significant associations between Vietnam service and mortality from the following cancers: prostate, lung, tongue, 'other' digestive organs and male breast, though the latter was based on only 3 cases. The validation study of self-reported illness showed a significant increase in incidence of non-Hodgkin's lymphoma among veterans.

However a number of these cancers are highly associated with smoking and alcohol intake and for the most part studies have not taken these factors into account when assessing cancer incidence or mortality.

A.3.3. Chapter III Diseases of the blood and blood forming organs (D50-D89)

This section does not include leukaemias, which were discussed in the previous section.

Studies have shown dioxin inducing anaemia and other effects on blood and blood-forming organs in laboratory animals[80] and case reports[81] but no significant

association has been noted in epidemiological studies[4, 43, 82]. Thus there is insufficient evidence to determine whether there is an association between Vietnam service or Agent Orange exposure with diseases of the blood and blood forming organs.[28]

A.3.4. Chapter IV Endocrine, nutritional and metabolic diseases (E00-E89)

The Vietnam Veteran Mortality Study[4] reported a significant decrease in endocrine, nutritional and metabolic diseases, SMR = 0.71 95% CI (0.53, 0.93) when compared with the Australian population. This was thought to be an example of the healthy worker effect as men with conditions such as childhood diabetes and congenital metabolic diseases would have been excluded from military service.

However the 2000 update of the Institute of Medicine's study of *Veterans and Agent Orange* (VAO) concluded that there was limited/suggestive evidence of association with herbicide exposure and type II diabetes.[28] This conclusion was supported and strengthened by a number of epidemiological studies involving Operation Ranch Hand Vietnam Veterans, [83-85] workers in US chemical plants,[86] residents of dioxin contaminated areas in the US[87] and victims of the Seveso, Italy accident.[41] These studies found either an increase in diabetes incidence or impaired glucose metabolism in the exposed populations.

A.3.5. Chapter V Mental and behavioural disorders (F00-F99)

Persons exhibiting many mental health disorders would have been excluded from military service. Nevertheless, many studies have shown an association of post-traumatic stress disorder (PTSD) with Vietnam service.[20, 88-90] Although this condition may lead to unhealthy behaviours or adverse outcomes such as suicide, as well as affecting family members,[91] in itself does not necessarily cause mortality and will not be considered further in this report.

A.3.6. Chapter VI Diseases of the nervous system (G00-G99)

Experimental studies in animals have shown that dioxin can effect the nervous system[92] but epidemiological studies noted below are equivocal.

The 2000 update of VAO concluded that there was inadequate/insufficient evidence for the association of exposure to herbicides and motor dysfunction, Parkinson disease, or cognitive and neuropsychiatric disorders.[28] The Australian validation study for multiple sclerosis (MS) and motor neurone disease (MND) in Vietnam veterans determined no increased risk for MS compared to the Australian population.[15] However when clinical notes and death certificates were considered, the number of MND cases among veterans was at the upper limited of expected cases, 3 cases observed, 1.2 expected (95% CI 0, 3.3). Michalek *et al*[93] noted a correlation with high exposure to Agent Orange and peripheral neuropathy. However the authors caution that this might be related to other conditions such as pre-clinical diabetes.

A.3.7. Chapter IX Diseases of the circulatory system (I00-I99)

Rheumatic heart diseases (I00-I09) are excluded from analysis of this chapter of diseases as veterans with these diseases would have been excluded from service.

Recent work with an animal model shows that exposure to dioxin leads to an increase in serum triglycerides and low-density lipoproteins and thus the early onset of cardiovascular disease.[94]

Seveso studies have also shown an elevated risk of ischaemic heart disease associated with dioxin exposure.[95, 96] An American study of chemical workers showed a significant trend between dioxin exposure and heart disease.[44] and a multi-national study also showed an increase in ischaemic heart disease among TCDD exposed workers.[97] The VVMS demonstrated a significant increase in ischaemic heart disease among Australian military Vietnam veterans, SMR = 1.10 (95% CI (1.01, 1.21).[4] The morbidity study also indicated an increase in self-reported incidence of circulatory diseases.[10]

Michalek *et al*[98] noted a significant increase in circulatory disease in the Operation Ranch Hand ground crew. Increase in high blood pressure was also associated with combat intensity among Vietnam veterans.[99] Furthermore elevated lipid levels, which contribute to cardiovascular disease, were described in Vietnam veterans with PTSD.[100]

The 2000 Veteran and Agent Orange update found inadequate/insufficient evidence to determine an association between herbicide exposure and circulatory disease and was unable to conclude that there was an increased risk among Vietnam veterans.[28]

A.3.8. Chapter X Diseases of the respiratory system (J00-J99)

Acute respiratory infections (J00-J22) are excluded from this analysis, as they would not be related to long term health effects of Vietnam service.

In a study of American chemical workers who were highly exposed to TCDD there was no evidence of increase in chronic bronchitis or COPD when controlling for cigarette smoking, alcohol intake and other confounders.[101] However the rate of chronic respiratory diseases was moderately increased among Seveso victims [41] and mortality from COPD was three time that in controls.[96]

Boscarino[102] found an association between severe stress of combat in Vietnam with an increase risk of chronic disease including respiratory disease among American veterans (OR = 1.54, p = 0.042). Nevertheless, the Institute of Medicine VAO report[28] concluded there was inadequate/insufficient evidence for the association of non-malignant respiratory disease and exposure to herbicides.

A.3.9. Chapter XI Diseases of the digestive system (K00-K93)

A study on Army Chemical Corps Vietnam veterans found an increased risk of mortality from digestive diseases (adjusted relative risk RR = 3.88, (95% C.I. =

1.12-13.4)) when compared with Army personnel who did not serve in Vietnam. This was primarily due to an increase in cirrhosis of the liver. However when all causes mortality was compared with the American population mortality among Vietnam veterans was reduced, presumably because of the "healthy worker effect".[103]

The Australian VVMS study did not find any significant increases in mortality due to diseases of the digestive system when compared with the Australian male population.[4] A comparison of national service veterans to non-veterans however, showed a significant increase in digestive diseases, mainly due to the increase in cirrhosis of the liver. Death due to cirrhosis of the liver was nearly three times that of the non-veteran comparison group, RR = 2.7 (1.2, 6.4).[6]

The Operation Ranch Hand study of Air Force personnel found a non-significant increase in mortality from digestive diseases, SMR = 1.7 (0.9, 3.2).[98] The 2000 VAO update[28] maintained that there was not sufficient evidence to change the conclusion of inadequate/insufficient data to evaluate the association between herbicide exposure and digestive system diseases.

A.3.10. Chapter XII Diseases of the skin and subcutaneous tissue (L00-L99)

Chloracne is a recognised consequence of dioxin exposure[28] however this is a non-fatal condition that occurs shortly after exposure and no new cases of this condition would be expected in the Vietnam veterans cohort.

The VVMS showed no deaths relating to this chapter of disease.[4] The American Proportional Mortality study showed a non-significant decrease in mortality due to skin disease compared to non-veterans.[66]

A.3.11. Chapter XIII Diseases of the musculoskeletal system and connective tissue (M00-M99)

Boscarino found a significant association between PTSD and musculoskeletal diseases among Vietnam veterans (OR = 1.78, p = 0.008).[102] However the VVMS did not find any effect of Vietnam service on mortality from diseases described in this chapter, nor did the American Proportionate Mortality Study.[4 66]

A.3.12. Chapter XIV Diseases of the genitourinary system (N00-N99)

The AVH and VVMS studies did not show any association of Vietnam service with mortality from diseases of the genitourinary system.[1 4]

A.3.13. Chapter XIX Injury, poisoning and certain other consequences of external causes (S00-T98) and Chapter XX External causes of morbidity and mortality (V01-Y98)

Several studies have shown an excess of mortality among Vietnam veterans due to external causes. In the early AVH study, 74% of all recorded deaths were

due to external causes and the relative mortality rate compared to non-veteran national servicemen was marginally elevated, RR = 1.3 (95% CI 1.0, 1.5).[104] An American proportional mortality study of Army and Marine veterans showed an excess mortality from external causes (PMR = 1.06), homicides (PMR = 1.16), and accidental poisoning (PMR = 1.19) compared to non-veterans.[40] However a 15 year follow-up of US Air Force personnel did not find a significant increase in mortality due to external causes.[98] The VVMS continued to show elevated mortality for external causes among Australian military personnel compared to the Australian population, SMR = 1.13 (95% CI 1.00, 1.27), mainly due to suicide, SMR = 1.21 (95% CI 1.02, 1.42).[4] Comparing national servicemen veterans with non-veterans the mortality rate from external causes did not reach significance, SMR = 1.10 (95% CI 0.85, 1.42).[6]

A.4. Summary and Discussion

The studies in the literature show that Vietnam service has presented veterans with unique health issues and with increasing time of follow-up from the conflict, health issues associated with Vietnam service are becoming more apparent. The Vietnam conflict exposed personnel to the hazards of military combat, chemical exposure, psychological stresses and difficult repatriation. All these exposures can contribute to long term health consequences. Although Agent Orange exposure has been extensively studied, veterans were exposed to other toxic chemicals during their service, which in general have not been investigated.

Even 30 years after the end of the Vietnam conflict, the healthy worker effect may still be a factor to consider when interpreting results of veteran mortality compared to the general population. Also most studies have not collected data on lifestyle factors such as smoking, drinking, and obesity, which may contribute to adverse health outcomes.

Australian studies have shown an increase in overall mortality for Vietnam veterans, which is highest among Navy personnel. Specific conditions showing statistically significant increased risk associated with Vietnam service in the Australian studies are:

- all cause mortality;
- mortality from all neoplasms;
- mortality from lung, prostate, tongue, and ‘other’ digestive organ cancers;
- mortality and morbidity from cirrhosis of the liver;
- mortality from ischaemic heart disease; and
- suicide.

Other conditions of concern highlighted in the Australian studies were brain cancer, motor neurone disease, and non-Hodgkins lymphoma.

American studies focused on the more specific association of disease with Agent Orange exposure rather than general Vietnam service as the Australian studies have done. Conditions that were considered to have sufficient evidence or limited/suggestive evidence of an association with herbicide exposure are:

- Non-Hodgkin's lymphoma;
- Hodgkin's disease;
- Soft-tissue sarcoma;
- Chloracne;
- Respiratory cancers;
- Prostate cancer;
- Multiple myeloma; and
- Type II diabetes.

The main differences between the American and Australian studies are that the VAO study has determined that there is limited/suggestive evidence of *no* association with herbicide exposure for gastrointestinal cancers and brain tumours whereas the Australian studies found an association with Vietnam service and these cancers.

The wide range of health effects associated with Vietnam service and Agent Orange exposure indicates a need for continued study of this population.

Table A.1: Reports and published peer-reviewed papers on health issues for Australian Vietnam veterans

Study [a]	Year	Type of Study	Results
"Pesticides and the Health of Australian Vietnam Veterans"[105]	1982	Senate Inquiry, public hearings	Concluded insufficient evidence that birth abnormalities, psychiatric disorders or mortality were excessive. Recommended mortality study to be done.
"The Australian Veterans' Health Studies Mortality Report", Part I [1]	1984	With AIHW, ABS, Cohort study of National service vets (19,209) vs non-vets (26,957)	Data to 1982. Overall mortality lower than Australian population. No elevated mortality by corps grouping, nor elevated cancer deaths, nor any other categories. # deaths too small (523 total) and follow-up time too short for meaningful conclusions
"The Australian Veterans' Health Studies Mortality Report", Part II[106]	1984	Case-control study	Compared characteristics of deceased veterans with those of random sample of survivors. Poorer education and psychological health related to deceased. Engineering corps members had excess mortaltiy.
"The Australian Veterans' Health Studies Mortality Report", Part III[107]	1984	Descriptive risk analysis	Correlated the risk of becoming a combat casualty in Vietnam with location of service and subsequent mortality. Increased mortality with engineering corps. No association with locality and mortality
Vietnam service and the risk of congenital anomalies. A case-control study[17]	1984	Case-control study	Investigated 8517 case-control pairs of children and correlated birth anomalies with father's Vietnam service. Found no increase in birth defects among children of Vietnam veterans.

Study [a]	Year	Type of Study	Results
Birth defects and Vietnam service[108]	1984	editorial	Commenting on Donovan study. Offered two caveats: Defects not evident at birth were not included in the study and lack of power to look at any single defect or category of defects.
Mortality among Vietnam veterans compared with non-veterans and the Australian population [109]	1985	retrospective cohort study	Compared 19 205 Vietnam national service veterans with 25 677 non-veterans. Followed until the beginning of 1982. Also compared with Australian population. Found no excess mortality.
"Use & Effects of Chemical agents on Australian Personnel in Vietnam"[19]	1985	'Evatt' Royal Commission, interviewed 2000 veterans, 150 written submissions	Concluded Vietnam veterans significantly healthier than rest of population but NS veterans slightly more likely to suffer from circulatory and digestive diseases. Recommended further study on dapsone carcinogenicity
Agent Orange controversy after the Evatt Royal Commission [110]	1985	editorial	Article summarising findings of royal commission
Mortality among Australian conscripts of the Vietnam conflict era. I. Death from all causes [111]	1987	Retrospective cohort mortality study	Published results from AVH study of National service veterans/non-veterans. Reported OR = 1.2 (1.0,1.4) adjusted for corps grouping and OR = 2.5 (95% Cl = 1.4-4) for Royal Australian Engineers.
Mortality among Australian conscripts of the Vietnam conflict era. II. Causes of death[104]	1987	Retrospective cohort study	Detailing causes of death from AVH study. National service veterans. Diseases of digestive tract and external causes were statistically elevated for Vietnam veterans compared to non-veterans. Follow-up period of 9-16 years too short to say anything definitive about neoplasms.

Study [a]	Year	Type of Study	Results
Mortality of Australian veterans of the Vietnam Conflict and the period and location of their Vietnam service[112]	1987	Retrospective cohort study	Correlated deaths rates with phase of conflict and location in Vietnam. Found no significant variations in death rates between time in Vietnam or location of service.
Risk factors for mortality in Australian Vietnam-era national servicemen: a case-control study[113]	1988	Case-control study of national servicemen	Extended the analysis of AVHS part II to identify risk factors for Vietnam veteran mortality.
Reproductive behaviour and consistent patterns of abnormality of Vietnam veterans [18]	1988	Analytical approach - 436 Tasmanian veterans and nominated neighbour 'control', questionnaire survey plus validation	Found greater foetal loss, more stillbirths and more deaths of offspring. Children had increase in chronic health problems and learning and behavioural problems.
The logic of a controversy: the case of Agent Orange in Australia[114]	1989	Commentary	Analyses the sociological and psychological processes around the continued rejection by the veteran community of the Evatt report findings
"Dapsone Exposure, Vietnam Service and Cancer Incidence"[5]	1992	Cohort study by AIHW of 115,407 Australian army	Looked at cancer incidence, did dose exposure comparisons and compared Malaria ±, No increase in overall cancer incidence for veterans
Mortality of former prisoners of war and other Australian veterans [3]	1992	Epidemiological review	Reviewed studies of WW II POWs and Fett *et al* on Vietnam veterans. Discussed healthy worker effect and need for continued surveillance.
Did Vietnam veterans get cancer from dapsone?[115]	1993	Editorial	Highlights findings of AIHW Dapsone study

Study [a]	Year	Type of Study	Results
"Vietnam service, Dapsone Use and Cancer"[116]	1994	AIHW, Female veterans (N = 46), cancer incidence & toxic reactions in male – case histories (N = 10)	Complemented larger Dapsone study. Numbers small but female showed elevated cancer incidence
Suicide risk factors among Australian Vietnam era draftees[21]	1995	Cohort study of suicide victims	Used log-linear model to assess risk factors for suicide in veterans. Found those that scored low on intelligence test score, postschool education, AWOL charge during service, and history of diagnosis and treatment of psychological problems had a much higher rate of suicide.
The Australian Vietnam Veterans Health Study: I. study design and response bias[9]	1996	Prospective cohort study	Random sample of 1000 veterans, 641 interviewed, 50 deceased, 309 non-responders. Veterans self-reported lower perceived health and happiness compared to Australian population, had greater frequency of medical consultations, especially for neoplasms and musculoskeletal complaints, and higher use of alcohol and cigarettes.
The Australian Vietnam Veterans Health Study: II. self-reported health of veterans compared with the Australian population[8]	1996	Cohort study of random sample of veterans – self-reported questionnaire survey	Correlated relationship of combat with physical health. Combat exposure was associated with increased mental health complaints, eczema, ulcers, deafness, chronic infection, back pain.
"Mortality of Vietnam Veterans"[4]	1997	Cohort study of 59,036 veterans	Mortality study of death data to Dec 1994. Showed a number of increases esp, neoplasms, prostate & lung
"Mortality of National Service Vietnam Veterans"[6]	1997	Cohort study of 43,595 National service veterans and non-veterans	Comparison of mortality. Eliminated 'healthy worker' confounder. Elevated RR for all causes, lung & brain cancers, cirrhosis, diseases of digestive system.

Study [a]	Year	Type of Study	Results
"Morbidity of Vietnam Veterans Male vol 1"[10]	1998	Questionnaire survey	Self-reported data from 40,030 male veterans (80% response rate)
"Morbidity of Vietnam Veterans Female vol 2" [11]	1998	Questionnaire survey	Self-reported data. Could only locate 278/484 female veterans on Nominal Roll but of those 81% completed questionnaire
"Morbidity of Vietnam Veterans: Validation study"[13]	1999	Validation of self-reported questionnaire survey	Found elevated rates of melanoma (483 cases, 380(342-418) expected) and prostate cancer (212 cases, 147 (123-171) expected)
"Morbidity of Vietnam veterans: Suicide in Vietnam veterans' children: Supplementary report no 1"[16]	2000	Validation of self-reported questionnaire survey	Found children of Vietnam veterans had suicide rate three times the expected rate for the general population.
"Morbidity of Vietnam veterans: Adrenal gland cancer, leukaemia and non-Hodgkin's lymphoma: Supplementary report no. 2"[14]	2001	Validation of self-reported questionnaire survey	Adrenal cancer (10 cases, 1 (0-3) expected) and AML (9-18 cases, 3 (0-6) expected) incidence elevated in veterans' children. Non Hodgkin's lymphoma higher than expected in veterans (66 cases, 48 (34-62) expected). All other leukaemia not elevated in veterans or their children.
"Morbidity of Vietnam veterans. Multiple sclerosis and motor neurone disease in Vietnam veterans: Supplementary report no. 3"[15]	2001	Validation of self-reported questionnaire survey	MND elevated if include deaths in validation (3-5 cases, 1.2 (0-3.3) expected). No elevation of MS

[a] Studies in quotes are reports. Other studies listed are published papers in peer reviewed journals. Many of the papers are reporting results from government or agency reports. The table does not include psycho-social studies on effect of Vietnam service.

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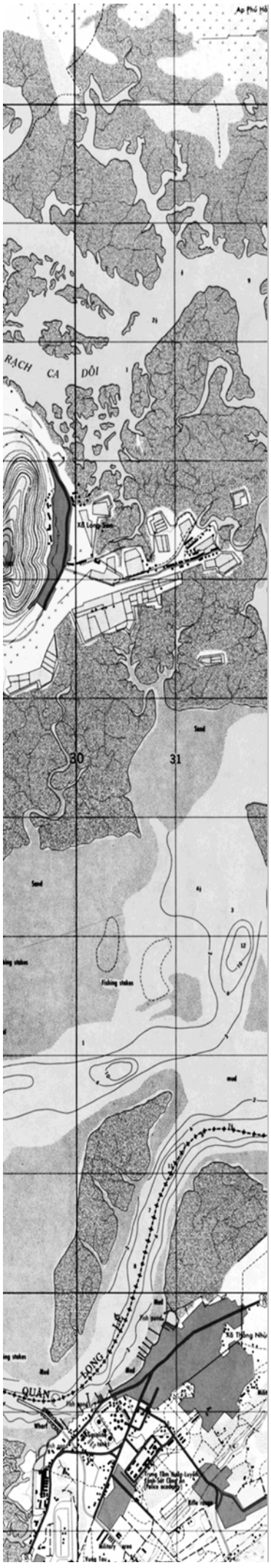

B

Study Protocol

Appendix B Study Protocol

This protocol relates to all four volumes to be published in this series of studies on the cancer incidence and mortality of Vietnam veterans.

Abbreviations

ABS	Australian Bureau of Statistics
AEC	Australian Electoral Commission
AIHW	Australian Institute of Health and Welfare
AML	Acute myeloid leukaemia
AVH	Australian Veterans Health Study, 1984
DIMA	Department of Immigration and Multicultural Affairs
HIC	Health Insurance Commission
ICD-10	International Classification of Disease – revision 10
MS	Multiple sclerosis
MND	Motor neurone disease
NDI	National Death Index
NHL	Non-Hodgkins leukaemia
NCSCH	National Cancer Statistics Clearing House
RAAF	Royal Australian Air Force
RAN	Royal Australian Navy
RR	Relative Rate
SMR	Standardised Mortality Ratio
VVMS	*Mortality of Vietnam Veterans: The veteran cohort study* 1997 report

Protocol

This document is the protocol for the *Third Vietnam Veteran Mortality Study*. The protocol was written in consultation with the Scientific Advisory Committee and the ex-Service organisation Consultative Forum.

B.1. Background

Several previous studies on Vietnam veteran mortality and health have been done. The 1984 *Australian Veterans Health Study* (AVH) was the first study to consider Vietnam veteran mortality. The 1997 *Mortality of Vietnam Veterans: The veteran cohort study* (VVMS), and the related 1997 *Mortality of National Service Vietnam Veterans* were the second mortality studies. In addition, a study on cancer incidence and dapsone exposure, *Dapsone exposure, Vietnam service and cancer incidence,* was completed in 1992 and morbidity surveys of male and female Vietnam veterans were completed in 1998, followed by validation studies in 1999-2000. A summary table of previous studies of Australian Vietnam veterans is in Table B.3.

The earliest studies were confounded by a 'healthy worker effect' of fit military recruits and showed reduced mortality compared to the Australian population. This effect was not so prominent in the later studies. Results of the VVMS showed that Vietnam veterans had elevated mortality rates for all neoplasms, prostate cancer, lung cancer, head and neck cancers, ischaemic heart disease, and suicide. Veterans had reduced mortality rates for endocrine diseases, mental disorders, and congenital diseases.

A recommendation of the 1997 VVMS was that the study be repeated after 2000. The Minister for Veterans Affairs agreed that the Repatriation Commission should undertake a third Vietnam veteran mortality study and the Commission has tasked the Department of Veterans' Affairs to conduct the study.

B.2. Aims

This study will seek to test the hypothesis that service in Vietnam did not increase mortality and cancer incidence among military personnel.

To answer the hypothesis the study aims will be:

1. To examine whether service in Vietnam during the Vietnam conflict increased the mortality rate of Vietnam veterans;

2. To examine whether service in Vietnam during the Vietnam conflict increased the overall cancer incidence of Vietnam veterans;

3. To examine whether service in Vietnam increased the mortality rate for specific conditions as ascertained by past studies and the literature review;

4. To examine whether service in Vietnam increased the cancer incidence for specific types of cancer as highlighted by past studies and the literature review;

5. To establish lists of personnel who served aboard HMA ships and army small ships deployed to Vietnam and determine mortality on a ship-by-ship basis, if practical;

6. To establish lists of ADF Personnel transported to and from Vietnam on the HMAS Sydney and determine mortality and cancer incidence, if practical; and

7. To analyse the effect of dapsone on the mortality and cancer incidence of Vietnam veterans, along the lines of the analysis published in 1992 by the AIHW.

B.3. Overview of study design

The study is a retrospective cohort study of Vietnam veterans. It will determine mortality and cancer incidence among this cohort from the time of their Vietnam service up until 31 December 2001 (29 to 39 years of follow-up). Mortality and cancer incidence will be compared with service personnel from the same time period who did not serve in Vietnam and with the Australian population.

This study builds on the 1997 *Mortality of Vietnam Veterans: The veteran cohort study* and the 1992 *Dapsone exposure, Vietnam service and cancer incidence.* In addition a general cancer incidence study and studies of subgroups of personnel travelling on or working in the HMAS Sydney, working in HMA ships and the 32 Small Ships Squadron will be completed.

The Nominal Roll of Vietnam veterans and appropriate comparison groups will be matched to several national databases to obtain mortality and cancer incidence data. Cancer incidence, the number of deaths, cause of death, and death rates will be tabulated for the study cohort. Published data on mortality and cancer incidence rates of all Australian males will be used to calculate the number of expected deaths / cancer incidence in the cohort by age and calendar year of death / cancer incidence in five year time periods.

For the mortality study comparisons will be reported using Standardised Mortality Ratios (SMR). That is, the ratio of the observed number of deaths due to a specific cause or group of causes to the expected number of deaths due to the same specific cause or group of causes for an age standard Australian population. Cancer incidence will be reported as Relative Rates (RR). That is, the ratio of

observed incident cancer cases in the exposed population (dapsone, Vietnam service) to the expected incident cancer cases in the non-exposed population (non-dapsone exposed, non-veteran, or Australian population) by calendar year and age.

If necessary, adjustment to SMR and RR will be made to account for under-ascertainment of the veteran population vital statistics.

B.3.1. Definition of Vietnam veteran

On the Nominal Roll, created in 1996 and revised in 1997, the Vietnam veteran is defined as:

> "All members of the Australian Defence Force (ADF) and the Citizen Military Forces (CMF) who were allotted or deemed allotted for service in Vietnam; all members of the ADF who landed in Vietnam including those who were seconded to the Army of the Republic of Vietnam (ARVN), the United States Air Force (USAF), the United States Navy (USN) and any other allied service; all members of Australian Army Training Teams Vietnam (AATTV); merchant seamen who sailed on ships chartered by the government for transport to Vietnam; all members, male and female, of civilian surgical teams; all members of Philanthropic Organisations; all members of the Australian Overseas Forces Fund and all official entertainers and journalists who saw service in Vietnam during the period between 23 May 1962 and 1 July 1973."

In this context, "allotted" means being the subject of an instrument in writing and "deemed allotted" means, in the absence of an instrument in writing, being regarded as the subject of an instrument in writing. The latter is important in the case of some RAAF and RAN personnel who were not specifically allotted at the time of their service in Vietnam.

This definition excludes:

- members of the diplomatic corps;
- entertainers other than those who were regarded as 'official';
- members of the Army of the Republic of Vietnam or of any other army who have become Australian citizens subsequently;
- officers of the Repatriation Commission, other than members of surgical teams;
- Australian citizens employed in Vietnam by overseas business organisations or governments; and
- civilian non-medical aid and charity workers other than members of philanthropic organisations who were regarded as official.

For the purposes of the mortality and cancer incidence study, the study cohort will comprise male ADF personnel and not the civilians included in the above definition.

B.3.1.1 Male veterans

The 1997 VVMS determined the number of male ADF Vietnam veterans coming within the scope of the definition was as follows:

Table B.1: Number of male military veterans by first Vietnam service (1997 Mortality Study)

Service	Group	Number	%	Comparison Group
Navy	On shore - Vietnam	761		
	At sea - Vietnam	1,038		
	Visit Vietnam	370		
	Logistic support	10,207		
Sub-total		12,376	21.3	
Army	Regular	21,307		37,983 [a]
	Regular - short term visitors	66		
	National service	19,383		24,909 [b]
	CMF	632		
Sub-total		41,388	71.1	
Air force	Stationed in Vietnam	4,245		
	Stationed outside Vietnam	193		
Sub-total		4,438	7.6	
Total		58,202	100	62,892

Note: Column total may not add up to 100 per cent due to rounding.
[a] Regular Army non-veterans from Dapsone study
[b] National service non-veterans from *Mortality of National Service Vietnam Veterans* report

B.4. Comparisons of interest

B.4.1. General

The study will determine the vital statistics, causes of death, and the incidence of cancer for all male Vietnam military veterans. It will make the following comparisons for veterans and several sub-populations of veterans for each of the three parameters of interest:

- Vietnam veterans vs Australian population;
- Vietnam veterans vs non-veteran army personnel;
- National service veterans vs non-veteran national service.

The first two comparisons will be further analysed by service grouping (Army, Navy, or Air Force).

B.4.2. Ships crews and passengers

Previous studies have shown an elevated mortality among Navy Vietnam veterans. This elevated mortality may be an artefact of imperfect adjustment for the under-ascertainment of Navy personnel, or related to a distinctive aspect of naval service. Preliminary studies suggest that the evaporative water supply used on naval vessels to produce potable water may have formed a unique environment for those personnel. The study will undertake several comparative studies to explore this finding:

- compare the mortality and cancer incidence of the nearly 600 veterans who served in the 32 Small Ships Squadron to other veterans, other Navy personnel, non-veteran Army personnel, and the Australian male population;
- compare the mortality and cancer incidence of those who travelled on the troop carrier HMAS Sydney to other veterans, non-veteran Army personnel and the Australian male population; and
- compare mortality and cancer incidence of RAN personnel on a ship-by-ship basis.

To enhance the understanding of the ship-by-ship analysis the researchers will hold a series of focus groups with crew members from Army and Navy ships. Focus groups will augment scarce historical archival data on distillation of potable water, type of food and its preparation, and medical conditions. The researchers will seek participants, who were ship engineers, cooks, supply officers, victuallers, and medical officers.

B.4.3. Dapsone exposure

In addition this present study will extend the Dapsone study published by the AIHW in 1992. It will compare the following groups:

- dapsone exposed vs non-exposed veterans;
- high exposure to dapsone vs those with low exposure;
- Vietnam veterans with malaria vs those without malaria;
- dapsone-exposed veterans vs non-veterans.

B.4.4. Specific causes of death to be examined

A well as total mortality, the study will consider several specific causes of death for which Vietnam veterans may differ from other Australians. A list of these a priori causes of death is in Table 1.4-2.

The a priori causes of death of interest have been identified through the results of previous DVA studies and review of the literature.

Table B.2: Summary of specific causes of death to be examined

Cause of death	ICD-10 chapter/codes	Source
Neoplasms	Chapter II / C00-D48	VVMS Study
Ischaemic heart disease	I20 – I25	VVMS Study
Prostate cancer	C61	VVMS Study / Morbidity study
Lung cancer	C33-C34	VVMS Study
Head and neck cancers	C01-C14,	VVMS Study
Cancer of other digestive organs	C26	VVMS Study
Male breast cancer	C50	VVMS Study
Suicide	X60 – X84	VVMS Study
Brain cancer	C71	National service study
Cirrhosis of the liver	K74	National service study
Diseases of the digestive system	K00 – K93	National service study
Motor neurone disease	G12.2	Morbidity study
Melanoma	C43	Morbidity study
Pancreatitis	K85	AVH Study
External causes	V01-Y98	AVH Study
Non-Hodgkin's lymphoma	C82,-C85, C96	Possible toxic chemical exposure
Primary liver cancer	C22	Possible toxic chemical exposure
Nasal cancer	C30	Possible toxic chemical exposure
Connective and soft tissue sarcoma	C47-C49	Possible toxic chemical exposure / VVMS study
Hodgkin's disease	C81	Possible toxic chemical exposure
Testicular cancer	C62	Possible toxic chemical exposure
Thyroid cancer	C73	Possible toxic chemical exposure
Leukaemia	C91-C95	Possible toxic chemical exposure
Multiple myeloma	C90	Possible toxic chemical exposure
Bladder cancer	C67	Possible toxic chemical exposure
Diabetes	E10 – E14	Possible toxic chemical exposure
COAD	J41 - J44	Smoking related diseases
Land transport accidents	V01 – V89	Alcohol related disease
Infective and parasitic diseases	Chapter I / A00 –B99	Proposed by veterans' organisations
Specific neurological disorders	G12 –G13, G35	Proposed by the DVA

B.5. Literature review

A literature review relevant to the study has been produced separately.
The purposes of the literature review are:

- to update the previous literature review with new information available on the health effects of Vietnam service;

- to identify from the current literature the causes of death to be targeted by the study;
- to identify those causes of death for which the proposed study would have sufficient power to detect a significant difference in mortality between the comparison groups;
- to identify those medical conditions for which Vietnam veterans may be at greater risk of death which could not be adequately accessed in the previous 1997 study.

B.6. Legislation

Two Acts of Parliament are relevant to the conduct of this study:

B.6.1. The Privacy Act 1988

This is the major piece of legislation in the area of privacy. Eleven Information Privacy Principles (IPP) address the collection, management and use of personal information. Disclosure of personal information by Commonwealth agencies is permitted in a number of circumstances specified by IPP. These include requirements or authorisation under law, (IPP 11).

Pursuant to subsections 95 (1), (2) and (3) of the Act, the National Health and Medical Research Council (NHMRC) periodically issues guidelines "designed to achieve the purpose of protecting privacy in the conduct of medical research in three ways:

1. first, they prohibit all medical research that might involve an unlawful interference with privacy from proceeding unless and until a decision has been made by an Institutional Ethics Committee (IEC) that the public interest in the research outweighs to a substantial degree the public interest in the protection of privacy;
2. second, they state the principles and matters that are to be considered and the reasons used in reaching that decision; and
3. third, they determine that the IEC is responsible for making that decision and set out the procedures that are to be followed in reaching that decision and in monitoring the conduct of research. The IEC must be composed and function in accordance with Supplementary Note 1, entitled Institutional Ethics Committees, as published from time to time in association with the NHMRC Statement on Human Experimentation."

In practice, this means that this study must be approved by properly constituted Ethics Committees, which act in accordance with current NHMRC guidelines in reaching their decisions to approve the study.

B.6.2. The Commonwealth Electoral Act 1918

In accordance with Regulation 8 of the Electoral and Referendum Regulations and Section 91 of the *Commonwealth Electoral Act 1918,* in Part 1 of Schedule 2, the Department of Veterans' Affairs is listed as a "Prescribed Authority" under that Act. This permits the Department to be given information from electoral sources that is not available publicly.

B.6.2.1 Data collection and processing

Several sources will be used to determine vital statistics, causes of death and incidence of cancer.

B.6.3. Nominal Roll

The Nominal Roll of all Vietnam veterans was completed for the 1997 study. This has undergone three revisions in consultation with veteran groups and the public and is considered accurate.

B.6.4. Determining vital statistics

A crucial task for this study is the accurate and complete determination of deaths and causes of death for Vietnam veterans. In the first instance the study will detail the Vietnam veterans who have died since 31 December 1994, the cut-off date for data collection for the 1997 *VVM* study, up until 31 December 2001. Through improved matching procedures we will endeavour to decrease the number of veterans lost to follow-up and seek to account for the 3.1% lost to follow-up in the 1997 *VVM*S.

A flow chart of the method used for the 1997 *VVMS* is in Appendix 1A. A diagram of the proposed matching procedure for this study is in Appendix 1B. The procedure entails simultaneously matching the Nominal Roll to seven databases listed below. A detailed algorithm for the method and criteria of matching will be finalised in consultation with the AIHW and other stakeholders. Those names for which no vital statistics can be obtained will be subject to manual searching in ex-service records and other databases. The simultaneous matching of the Nominal Roll with the seven databases will maximise identification of vital statistics. Furthermore it will allow for a determination of the sensitivity and specificity of each of the databases, which can be used for future research studies.

B.6.4.1 Search of DVA Client Data Base

DVA maintains an automated database, the Client Data Base, which provides a central, authoritative source of information about veterans who have registered for any benefit provided by Veterans' Affairs. The DVA maintains stringent checks and balances for its Client Data Base (CDB). If a veteran is in receipt of a DVA payment, then that veteran is assumed alive. Files showing that a veteran has died have been confirmed by evidence of a death certificate sighted by an officer of the DVA. However cause of death is not always recorded.

Although there are over 42,000 Vietnam veterans recorded on the CDB, the database does not have data on Vietnam veterans who have not registered for any benefit provided by Veterans' Affairs and those short-term visitors and others not covered under Repatriation legislation. For these veterans it will be necessary to check other data bases, and in turn information about Vietnam veterans from these other data bases can be cross-checked against the DVA CDB to increase the reliability of data.

B.6.4.2 Search of National Death Index

The AIHW maintains the National Death Index (NDI), which collates data from the death registries from individual States and Territories. The NDI includes a mortality database which contains information on each person's underlying cause of death by International Statistical Classification of Diseases, Injuries and Causes of Death (ICD) code. ICD-9 classification was used from 1979 to 1996 and use of the ICD-10 classification commenced in 1997.

In the *VVMS*, the NDI matching was problematic in that it identified only 60% of deaths not known to DVA from the CDB. Furthermore, approximately 20% of matches with the NDI determined incorrectly that a live subject was dead. Liaison with the AIHW has determined that the researchers can expect an improvement of the matching results. Nevertheless, adjustments to the statistical analysis may need to be considered to correct for under-ascertainment.

B.6.4.3 Search of electoral rolls

Nominal Roll veterans will be matched against the most recent Australian electoral records to identify:

- those veterans who are known to have been alive at the date of the electoral roll compilation; and
- those not confirmed to be alive.

The matching of the Nominal Roll to the electoral roll will be done by the AIHW.

B.6.4.4 Search of Medicare database by the Health Insurance Commission

The veterans will be matched with the Medicare claim database. Each matched record can be linked to the claim database to determine the date on which the subject last received a medical service, that is, the date they were last known to be alive.

B.6.4.5 Search of cancer registers

The Nominal Roll will be matched against the National Cancer Statistics Clearing House (NCSCH). This match will identify those who have died of cancer and those who currently have cancer but are still alive. The veterans diagnosed with cancer identified through the NCSCH will form the basis for the Cancer Incidence Sub-study.

The AIHW will perform the matching of the Nominal Rolls with the NCSCH.

B.6.4.6 Search of Department of Immigration and Multicultural Affairs records of arrivals, departures and Passports

The Nominal Roll may be matched with Department of Immigration and Multicultural Affairs and Passports records. This will identify those veterans who are alive but living or travelling overseas.

B.6.4.7 Vietnam veteran and military unit organisations

The list of names of those not confirmed alive or dead through all the above searches may then be matched with membership and death lists maintained by Vietnam veteran and military unit organisations to identify vital statistics not obtainable from other sources. A death identified from these sources will require evidence of a death certificate for the purposes of the study.

Lists of the recently allocated National Service Commemorative Medal will also be accessed to identify any veterans not previously allocated.

B.6.4.8 Other potential sources of information

The feasibility of searching for information on vital statistics of Vietnam veterans from other sources, such as:

- police and corrective services records;
- New Zealand registry of Birth, Deaths & Marriages;
- White pages;
- manual follow-ups;

will be explored, if necessary.

B.6.4.9 Focus group analysis

Two to four focus groups will be conducted separately with Army and Navy crews. Six to twelve veterans will participate in each group. Topic areas for discussion, questions and prompts will be prepared prior to the focus group and the epidemiologist for the study will moderate the groups. Discussion will be audio taped and transcribed, with veterans' permission. Thematic analysis using hierarchical coding will be employed to assess trends and similarities in experiences, as well as factual information on water distillation equipment and procedures. Where available, archival documents will be obtained to confirm and supplement the information received through the focus groups.

B.7. Power of the study

Tables in Appendix 2 give the details of the power estimates for the study. The tables give the probability of detecting a significant increase in mortality for selected causes for the groups of interest compared to the Australian male

population. Several assumptions were made in the calculations. The ABS 2000 age standarised mortality rates for all males were used. The comparison group was all Australian males and a one-sided statistical test was used. The length of follow-up of 34 years and vital statistics for all participants were assumed.

The analysis shows that there is good statistical power to detect an increase in mortality for most conditions for all service branches. The power is less for rare diseases among RAAF personnel. For the 32 Small Ship Squadron there is significant power to detect increases in all cause mortality (for RR > 1.3) and all neoplasms if the relative risk is greater than 1.5. Power estimates on a ship-by-ship basis for RAN personnel shows that for those ships with greater than 650 crew, there is sufficient power to detect increase in mortality for all causes and all neoplasms.

The final table in Appendix 2 shows an example of power calculations for cancer incidence among Army veterans.

B.8. Data analysis

The data will be analysed by the epidemiologist at DVA in consultation with the AIHW and others as deemed necessary. Standard statistical analytical techniques will be employed. Mortality will be reported as Standardised Mortality Ratios (SMR) using the person-years method. The person-years method entails classifying deaths and the length of time each cohort member is alive ('person-time') during the period of observation into an age and calendar time grid. In this study, the degree of subdivision will correspond to 5-year age groups and five calendar years. The age and calendar year specific death rates for the cohort will be computed as the total number of deaths in the appropriate cell divided by the total person-time for that cell.

To compare the mortality in the cohort with the mortality in the national population, the number of expected deaths in each cell, based on national mortality rates, will be computed by multiplying the person-time in the cell by the national death rate for the corresponding 5 year age group and calendar years. Summing these expected deaths over the whole matrix gives the total number of deaths that would be expected in the cohort if the age- and year-specific mortality rates for the cohort were identical to those of the Australian male population.

The ratio of the total *observed* deaths in the cohort and the total *expected* deaths in the cohort is the *Standardised Mortality Ratio* (SMR), which is a measure of the relative mortality rate between the cohort and the reference population. An SMR greater than one indicates higher death rates in the cohort compared with the Australian male population, adjusted for age and calendar year. An SMR less than one reflects lower death rates in the cohort.

Death rates for specific causes of death will be calculated by counting only observed deaths with specific ICD-10 codes and basing the calculation of expected deaths on the corresponding national death rates for those ICD codes. Analysis will focus on causes of death identified in Table 1.4-1 as of *a priori* interest.

Cancer incidence, including the extension of the Dapsone study, will report results as relative cancer incidence rate (RR) between the exposed and non-exposed groups of interest.

In addition, deaths, cancer incidence, and person-year matrices will be further subdivided by service branch and for RAN personnel and members of the 32 Small Ship Squadron, by the ship in which they served. Poisson regression modelling will be used to investigate the estimated relative death rate for all causes among these subgroups. Poisson regression is the established method for analysis of cohort studies. It allows for analysis of a cohort with unequal periods of follow-up and controls for potential confounders, such as age, corps grouping, and length of service in Vietnam. Parameter estimates of incidence rates and 95% confidence intervals are readily obtained from the regression models

Several statistical packages will be used for the data management and analysis. Data will be initially managed on EXCEL and ACCESS spreadsheets. Initial processing and calculation of person-years will be performed in SPSS. Poisson and logistic regression modelling will be performed using STATA.

B.9. Study committees

Several committees will be established to oversee the study. These committees will comprise representatives of relevant stakeholders and expert advisers to ensure the study is inclusive and of the highest quality.

B.9.1. Consultative Forum

The consultative forum will keep a non-scientific watching brief on the study, report to the Repatriation Commission and consist of representatives from:

- Repatriation commission, Chair
- Minister's office
- Vietnam Veterans Association of Australia
- Vietnam Veterans' Federation
- Returned and Services League
- Australian Veterans and Defence Services Council (AVADSC)
- Naval Association of Australia
- Department of Veterans Affairs (5 members).

The consultative committee will meet:

- prior to commencing the study to approve membership of the other committees and study protocol;
- during the study to monitor overall progress; and
- at completion of the study to comment on the draft report.

A member of the Consultative Forum will be appointed to sit on the Scientific Advisory Committee.

B.9.2. Scientific Advisory Committee

The Scientific Advisory Committee, comprising experts in appropriate fields, will be the final arbiters of scientific matters in the conduct of the study. They will report to and meet:

- prior to commencing the study to approve the protocol;
- periodically during the study to monitor scientific progress; and
- after completion of the study to approve the presentation of the study findings.

A member of the Scientific Advisory Committee will be appointed to sit on the Consultative Forum.

B.9.3. Ethics committee and involvement of other organisations

The following Ethics Committees will review the study protocol and aspects of the its conduct:

- Medical Research Ethics Committee, Department of Veterans'Affairs will be responsible for providing ethical clearance for the conduct of the study;
- Ethics Committee, Australian Institute of Health and Welfare (AIHW), will be responsible for providing ethical clearance for the use of the National Death Index; and
- Ethics committees of individual states will be responsible for ethical clearance to cancer registries.

Other organisations that may be involved with this study are those that hold registers which the study staff would like to access for the names of Vietnam veterans. The organisations and registers include:

- Health Insurance Commission
- Department of Immigration and Multicultural Affairs
- Passports.

B.9.4. Project Team

The project team will comprise the following people:

- Dr Eileen Wilson – epidemiologist, DVA
- Dr Keith Horsley – director of research studies, DVA
- Ms Catherine Kinsella, secretariat, DVA
- Dr Paul Jelfs, AIHW
- Mr Robert van der Hoek, AIHW

- Other consultants as deemed necessary.

B.10. Reporting

Progress of the study will be reported to the Consultative Forum and the Scientific Advisory Committee at periodic meetings. The Consultative Forum will comment on and the Scientific Advisory Committee will approve and sign off on the draft of the final report prior to forwarding to the Repatriation Commission. The Repatriation Commission will provide the final report to the Minister for Veterans Affairs who will release the report to the public. No part of the study will be made public prior to Ministerial release.

After publication of the report, the study team will seek to publish key results in peer-reviewed scientific journals.

Privacy and confidentiality will be maintained at all times, in accordance with the aforementioned legislation, and no individuals will be identified in any reports.

B.11. Strengths and limitations of the study

This study will be a comprehensive mortality and cancer incidence study of Vietnam veterans. It will include all groups of veterans and make comparisons between several subgroups of veterans and non-veteran military and civilian populations. It will be the first time a cancer incidence study has been undertaken for Navy and RAAF Vietnam veterans. The study is being conducted 29 to 39 years following Vietnam service, which allows for sufficient time for many conditions with a long latency to develop.

As this study follows several earlier studies, the Project Team will be able to build on the information gained previously to enhance the present study. The Nominal Roll is complete and considered accurate and the data from the 1997 Mortality Study has been safely stored and is uncorrupted. That study collected mortality data to December 1994. The present study will add seven more years of data to this database and attempt to capture those for whom vital statistics could not be matched. The most recent cancer incidence study for this cohort was the 1992 Dapsone study, which collected data to December 1989 for 115,407 male Army personnel who served in Vietnam or Australia during the Vietnam conflict years. The present study will extend the data by 12 years and include Navy and Air Force personnel. The extension of the Dapsone study will correlate dapsone and malaria exposure to cancer incidence and mortality.

However as in other epidemiological studies, this study will only identify statistical associations, not causal associations, between exposure and disease. These statistical associations have a degree of imprecision as indicated by confidence intervals and the risk of cancer may be influenced by other factors not related to dapsone exposure or Vietnam service that are not measured in this study. These confounding factors, such as cigarette smoking, sunlight exposure or other lifestyle factors may mask any real association between dapsone exposure, Vietnam service, and mortality or cancer incidence.

Data matching techniques have improved in recent years and the researchers anticipate a reduction in the number of veterans lost to follow-up. Also the number of deaths among the cohort will have increased as the cohort ages. The combination of the increased number of deaths and reduced number lost to follow-up will increase the accuracy of the SMR estimates.

In past studies the 'healthy serviceman' effect of the Vietnam veterans, who were required to be fit for service, influenced the interpretation of the study results. This effect will have less influence on the data with the increased time of follow-up from Vietnam service. A more meaningful comparison will be able to be made between veterans and the general Australian population.

Table B.3: Reports on health issues for Australian Vietnam veterans

Study	Year	Type of Study	Results
"The Australian Veterans' Health Studies Mortality Report", Part I [1]	1984	With AIHW, ABS, Cohort study of National service vets (19,209) vs non-vets (26,957)	Data to 1982. Overall mortality lower than Australian population. No elevated mortality by corps grouping, nor elevated cancer deaths, nor any other categories. # deaths too small (523 total) and follow-up time too short for meaningful conclusions
"The Australian Veterans' Health Studies Mortality Report", Part II[2]	1984	Case-control study	Compared characteristics of deceased veterans with those of random sample of survivors. Poorer education and psychological health related to deceased. Engineering corps members had excess mortaltiy.
"The Australian Veterans' Health Studies Mortality Report", Part III[3]	1984	Descriptive risk analysis	Correlated the risk of becoming a combat casualty in Vietnam with location of service and subsequent mortality. Increased mortality with engineering corps. No association with locality and mortality

"Dapsone Exposure, Vietnam Service and Cancer Incidence"[4]	1992	Cohort study by AIHW of 115,407 Australian army	Looked at cancer incidence, did dose exposure comparisons and compared Malaria ±, No increase in overall cancer incidence for veterans
"Vietnam service, Dapsone Use and Cancer[5]	1994	AIHW, Female veterans (N = 46), cancer incidence & toxic reactions in male – case histories (N = 10)	Complemented larger Dapsone study. Numbers small but female showed elevated cancer incidence
"Mortality of Vietnam Veterans"[6]	1997	Cohort study of 59,036 veterans	Mortality study of death data to Dec 1994. Showed a number of increases esp, neoplasms, prostate & lung
"Mortality of National Service Vietnam Veterans"[7]	1997	Cohort study of 43,595 National service veterans and non-veterans	Comparison of mortality. Eliminated 'healthy worker' confounder. Elevated RR for all causes, lung & brain cancers, cirrhosis, diseases of digestive system.
"Morbidity of Vietnam Veterans" Male vol 1[8]	1998	Questionnaire survey	Self-reported data from 40,030 male Vets (80% response rate)
"Morbidity of Vietnam Veterans" Female vol 2 [9]	1998	Questionnaire survey	Self-reported data. Could only locate 278/484 female Vets on Nominal Roll but of those 81% completed questionnaire
"Morbidity of Vietnam Veterans: Validation study"[10]	1999	Validation of self-reported questionnaire survey	Found elevated rates of melanoma (483 cases, 380(342-418) expected)and prostate cancer (212 cases, 147 (123-171) expected)

"Morbidity of Vietnam veterans: Suicide in Vietnam veterans' children: Supplementary report no 1"[11]	2000	Validation of self-reported questionnaire survey	Found children of Vietnam veterans had suicide rate three times the expected rate for the general population.
"Morbidity of Vietnam veterans: Adrenal gland cancer, leukaema and non-Hodgkin's lymphoma: Supplementary report no. 2"[12]	2001	Validation of self-reported questionnaire survey	Adrenal cancer (10 cases, 1 (0-3) expected) and AML (9-18 cases, 3 (0-6) expected) incidence elevated in veterans' children. Non Hodgkin's lymphoma higher than expected in veterans (66 cases, 48 (34-62) expected). All other leukaemia not elevated in veterans or their children.
"Morbidity of Vietnam veterans. Multiple sclerosis and motor neurone disease in Vietnam veterans: Supplementary report no. 3"[13]	2001	Validation of self-reported questionnaire survey	MND elevated if include deaths in validation (3-5 cases, 1.2 (0-3.3) expected). No elevation of MS

References

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8. Commonwealth Department of Veterans' Affairs. Morbidity of Vietnam Veterans: A Study of the Health of Australia's Vietnam Veteran Community. Volume 1 Male Vietnam Veterans Survey and Community Comparison Outcomes. Canberra: Department of Veterans' Affairs, 1998.

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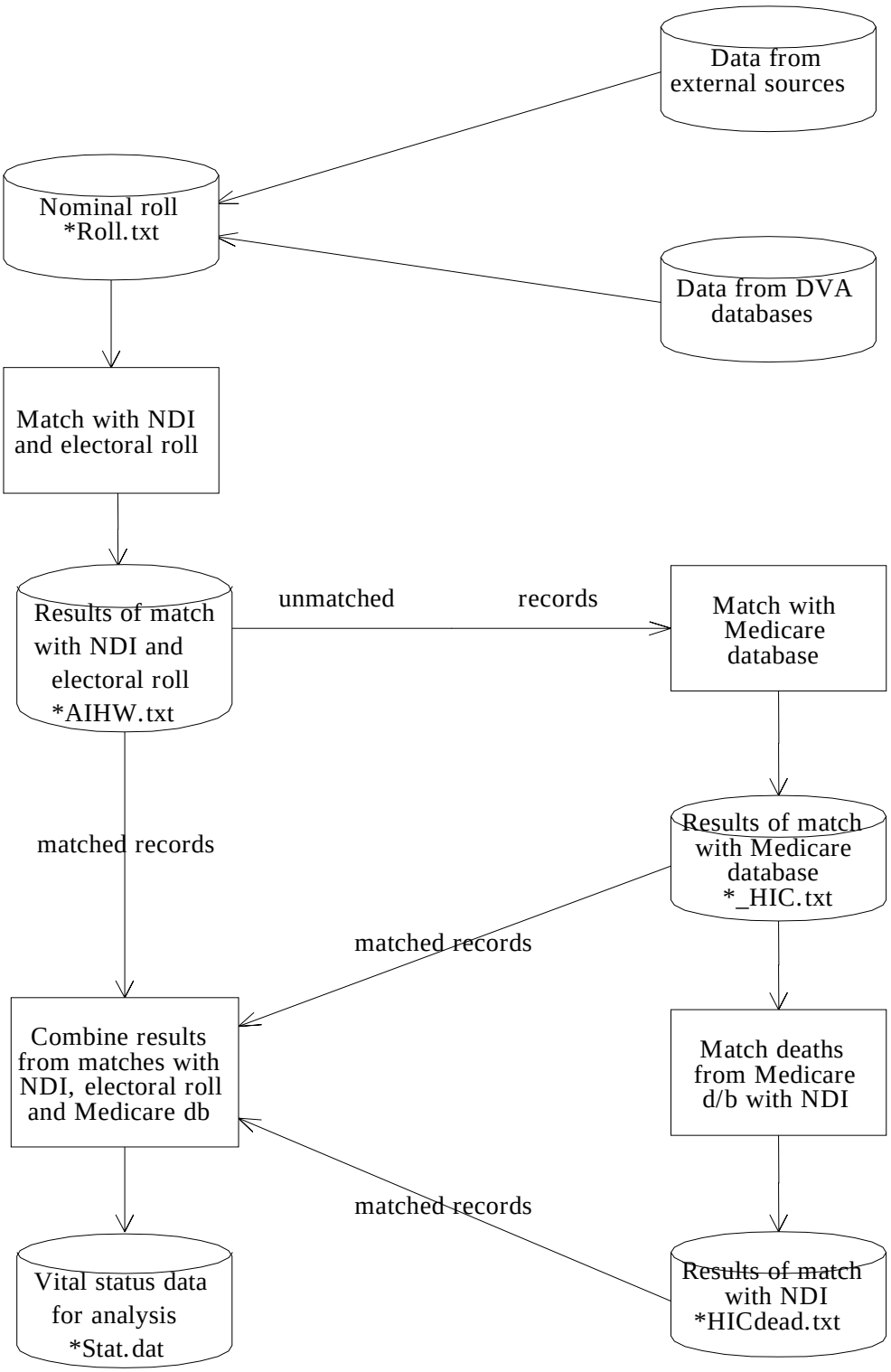
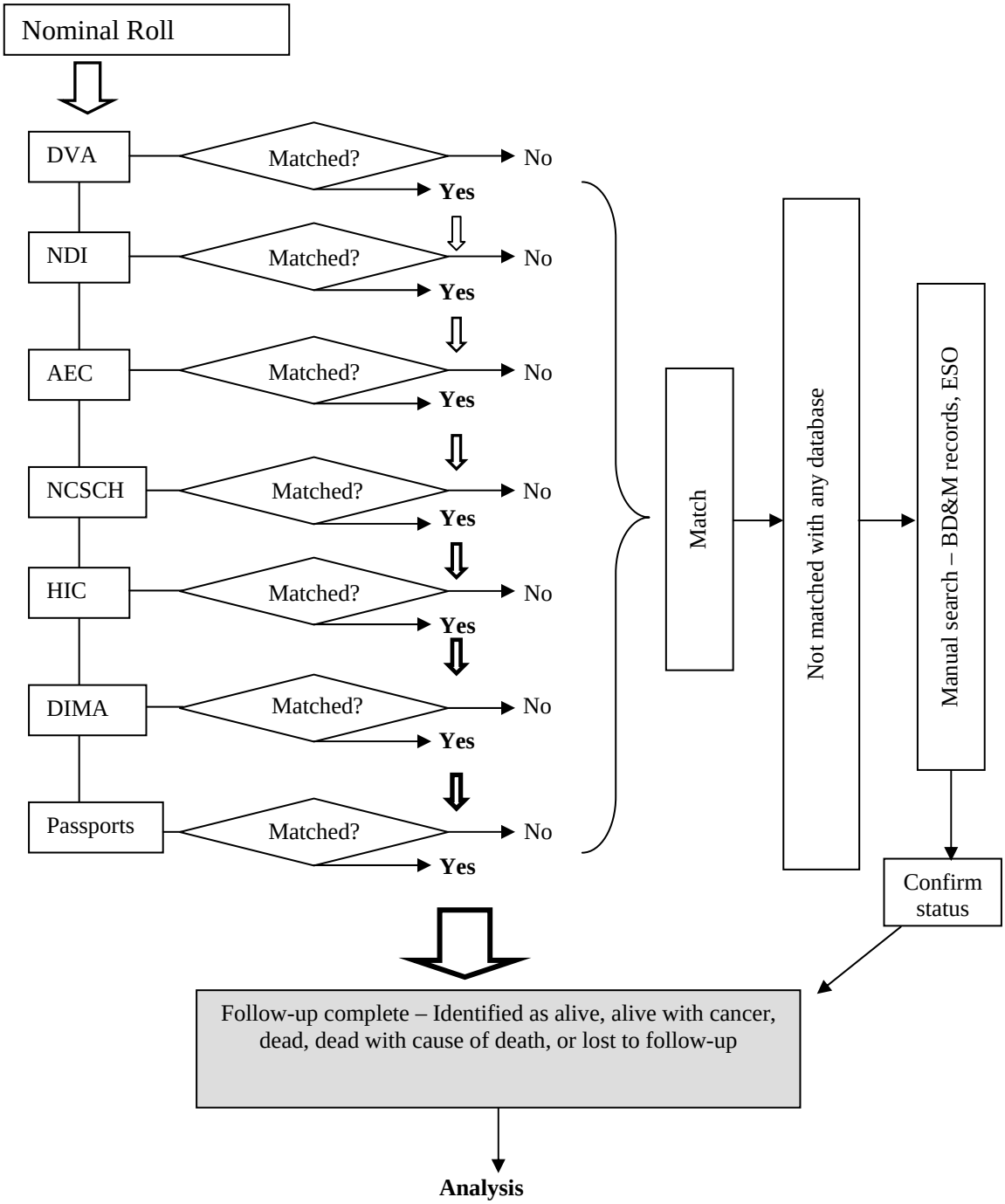
12. AIHW. Morbidity of Vietnam veterans: Adrenal gland cancer, leukaema and non-Hodgkin's lymphoma: Supplementary report no. 2. Canberra: Australian Institute of Health and Welfare, 2001.

13. AIHW. Morbidity of Vietnam veterans. Multiple sclerosis and motor neurone disease in Vietnam veterans: Supplementary report no. 3. Canberra: Australian Institute of Health and Welfare, 2001.

Study Protocol Appendix 1A: Previous matching protocol



Study Protocol Appendix 1B: Proposed matching protocol for Vietnam Veteran Mortality Study



The Nominal Roll will be matched simultaneously with the seven databases. Those not matched with any database will undergo manual searches with BD&M records and ex-service organisations records.

Study Protocol Appendix 2: Power calculations

Mortality

Army

National service

Navy

RAAF

32 Small Ship Squadron

Naval Units

Cancer Incidence

Army

Army

Estimated Power for Third Vietnam Veteran Mortality Study

Disease (ICD-10)	Standardised Death Rate[a]	% Probability of detecting changes in the relative risk of a given disease											
		Relative Risk (Ratio of change in disease incidence in study population)											
		1	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	2	2.2	2.4
All neoplasms (C00-D48)	215.4	5.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Malignant neoplasms (C00-C97)	211.2	5.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Lip, oral cavity and pharynx (ABS 1997)	4.9	5.0	20.2	47.5	75.0	91.7	98.0	99.7	100.0	100.0	100.0	100.0	100.0
Digestive organs (C15-C26)	59.3	5.0	88.5	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
pancreas (C25)	9.0	5.0	29.2	69.1	93.3	99.3	100.0	100.0	100.0	100.0	100.0	100.0	100.0
liver (C22)	5.3	5.0	21.1	50.0	77.9	93.4	98.7	99.8	100.0	100.0	100.0	100.0	100.0
Melanoma (C43)	6.4	5.0	23.6	56.5	84.3	96.5	99.5	100.0	100.0	100.0	100.0	100.0	100.0
Brain (C71)	6.3	5.0	23.4	55.9	83.8	96.3	99.5	100.0	100.0	100.0	100.0	100.0	100.0
Prostate (C61)	28.7	5.0	62.6	98.6	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Trachea, bronchus and lung (C33, C34)	48.0	5.0	81.8	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Lymphatic and haematopoietic (C81-C96)	21.6	5.0	52.4	95.4	99.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
leukaemia (C91-C95)	8.1	5.0	27.3	65.1	91.0	98.8	99.9	100.0	100.0	100.0	100.0	100.0	100.0
Benign and unspecified (D00-D48)	4.2	5.0	18.5	42.8	69.2	87.7	96.3	99.2	99.9	100.0	100.0	100.0	100.0
All disease of circulatory system (I00-I99)	254.3	5.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
ischaemic heart disease	182.3	5.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Cerebrovascular disease (I60-I69)	53.2	5.0	85.2	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Diseases of respiratory system (J00-J99)	64.0	5.0	90.5	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Diseases of digestive system (K00-K93)	21.5	5.0	52.2	95.3	99.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Diabetes (E10-E14)	16.9	5.0	44.5	90.3	99.6	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Diseases of nervous system (G00-G99)	19.7	5.0	49.3	93.8	99.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Accidents, poisoning and violence (V01-Y98)	58.4	5.0	88.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
All causes	710.1	5.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[a] For males per 100,000 per year. Source: Australian Bureau of Statistics, 2000.

Notes: Shaded area indicates where study power has less than 85% chance of detecting change in disease at the 0.05 level of significance

Assumptions:			
	Australian males	Number of individuals in comparison population (male)	9000000
	Army	Number of exposed participants in the study population	41388
		Length of time of follow-up of the study population (yrs)	34
		All participants traced	

National service

Estimated Power for Third Vietnam Veteran Mortality Study

Disease (ICD-10)	Standardised Death Rate[a]	% Probability of detecting changes in the relative risk of a given disease											
		Relative Risk (Ratio of change in disease incidence in study population)											
		1	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	2	2.2	2.4
All neoplasms (C00-D48)	215.4	5.0	88.5	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Malignant neoplasms (C00-C97)	211.2	5.0	87.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Lip, oral cavity and pharynx (ABS 1997)	4.9	5.0	10.9	20.1	32.2	46.0	59.7	71.9	81.7	88.8	96.5	99.1	99.8
Digestive organs (C15-C26)	59.3	5.0	42.3	88.3	99.4	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
pancreas (C25)	9.0	5.0	13.9	29.1	48.4	67.3	82.1	91.5	96.5	98.7	99.9	100.0	100.0
liver (C22)	5.3	5.0	11.2	21.0	33.9	48.4	62.6	74.9	84.3	90.8	97.4	99.4	99.9
Melanoma (C43)	6.4	5.0	12.0	23.5	38.5	54.8	69.7	81.6	89.8	94.8	98.9	99.8	100.0
Brain (C71)	6.3	5.0	12.0	23.3	38.1	54.2	69.2	81.0	89.3	94.5	98.8	99.8	100.0
Prostate (C61)	28.7	5.0	26.0	62.4	89.1	98.3	99.8	100.0	100.0	100.0	100.0	100.0	100.0
Trachea, bronchus and lung (C33, C34)	48.0	5.0	36.6	81.6	98.2	99.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Lymphatic and haematopoietic (C81-C96)	21.6	5.0	21.9	52.1	80.1	94.6	99.0	99.9	100.0	100.0	100.0	100.0	100.0
leukaemia CC91-C95)	8.1	5.0	13.3	27.2	45.1	63.4	78.5	88.8	94.9	97.9	99.7	100.0	100.0
Benign and unspecified (D00-D48)	4.2	5.0	10.3	18.4	29.1	41.5	54.2	66.1	76.2	84.2	94.0	98.1	99.5
All disease of circulatory system (I00-I99)	254.3	5.0	92.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
ischaemic heart disease	182.3	5.0	83.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Cerebrovascular disease (I60-I69)	53.2	5.0	39.2	85.0	98.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Diseases of respiratory system (J00-J99)	64.0	5.0	44.5	90.4	99.6	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Diseases of digestive system (K00-K93)	21.5	5.0	21.8	52.0	80.0	94.5	99.0	99.9	100.0	100.0	100.0	100.0	100.0
Diabetes (E10-E14)	16.9	5.0	19.0	44.3	71.1	89.1	97.0	99.4	99.9	100.0	100.0	100.0	100.0
Diseases of nervous system (G00-G99)	19.7	5.0	20.7	49.1	76.8	92.8	98.5	99.8	100.0	100.0	100.0	100.0	100.0
Accidents, poisoning and violence (V01-Y98)	58.4	5.0	41.8	87.8	99.3	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
All causes	710.1	5.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[a] For males per 100,000 per year. Source: Australian Bureau of Statistics, 2000.

Notes: Shaded area indicates where study power has less than 85% chance of detecting change in disease at the 0.05 level of significance

Assumptions:

NS non-vets*	Number of individuals in comparison population (male)	24646
NS vets*	Number of exposed participants in the study population	18949
	Length of time of follow-up of the study population (yrs)	34
	All participants traced	

*Excludes National service personnel who served less than one year

Navy

Estimated Power for Third Vietnam Veteran Mortality Study

Disease (ICD-10)	Standardised Death Rate[a]	% Probability of detecting changes in the relative risk of a given disease											
		Relative Risk (Ratio of change in disease incidence in study population)											
		1	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	2	2.2	2.4
All neoplasms (C00-D48)	215.4	5.0	92.1	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Malignant neoplasms (C00-C97)	211.2	5.0	91.6	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Lip, oral cavity and pharynx (ABS 1997)	4.9	5.0	11.5	21.8	35.4	50.5	65.0	77.2	86.3	92.3	98.1	99.6	99.9
Digestive organs (C15-C26)	59.3	5.0	46.5	91.9	99.8	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
pancreas (C25)	9.0	5.0	14.8	31.9	53.1	72.7	86.7	94.5	98.1	99.4	100.0	100.0	100.0
liver (C22)	5.3	5.0	11.8	22.8	37.3	53.2	68.0	80.0	88.5	93.9	98.7	99.8	100.0
Melanoma (C43)	6.4	5.0	12.7	25.6	42.4	59.9	75.1	86.2	93.1	96.9	99.5	99.9	100.0
Brain (C71)	6.3	5.0	12.7	25.4	41.9	59.3	74.5	85.7	92.8	96.7	99.5	99.9	100.0
Prostate (C61)	28.7	5.0	28.5	67.7	92.6	99.2	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Trachea, bronchus and lung (C33, C34)	48.0	5.0	40.2	86.2	99.1	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Lymphatic and haematopoietic (C81-C96)	21.6	5.0	23.8	57.1	84.9	96.8	99.6	100.0	100.0	100.0	100.0	100.0	100.0
leukaemia (C91-C95)	8.1	5.0	14.1	29.8	49.6	68.8	83.4	92.4	97.0	98.9	99.9	100.0	100.0
Benign and unspecified (D00-D48)	4.2	5.0	10.8	20.0	32.0	45.6	59.3	71.5	81.3	88.5	96.3	99.0	99.8
All disease of circulatory system (I00-I99)	254.3	5.0	95.5	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
ischaemic heart disease	182.3	5.0	87.5	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Cerebrovascular disease (I60-I69)	53.2	5.0	43.2	89.2	99.5	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Diseases of respiratory system (J00-J99)	64.0	5.0	49.0	93.6	99.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Diseases of digestive system (K00-K93)	21.5	5.0	23.8	56.9	84.7	96.7	99.6	100.0	100.0	100.0	100.0	100.0	100.0
Diabetes (E10-E14)	16.9	5.0	20.6	48.7	76.4	92.5	98.4	99.7	100.0	100.0	100.0	100.0	100.0
Diseases of nervous system (G00-G99)	19.7	5.0	22.5	53.8	81.9	95.5	99.3	99.9	100.0	100.0	100.0	100.0	100.0
Accidents, poisoning and violence (V01-Y98)	58.4	5.0	46.0	91.5	99.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
All causes	710.1	5.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[a] For males per 100,000 per year. Source: Australian Bureau of Statistics, 2000.

Notes: Shaded area indicates where study power has less than 85% chance of detecting change in disease at the 0.05 level of significance

Assumptions: Australian males — Number of individuals in comparison population (male) 9000000

Navy — Number of exposed participants in the study population 12376

Length of time of follow-up of the study population (yrs) 34

All participants traced

RAAF — Estimated Power for Third Vietnam Veteran Mortality Study

Disease (ICD-10)	Standardised Death Rate[a]	% Probability of detecting changes in the relative risk of a given disease											
		Relative Risk (Ratio of change in disease incidence in study population)											
		1	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	2	2.2	2.4
All neoplasms (C00-D48)	215.4	5.0	57.4	97.4	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Malignant neoplasms (C00-C97)	211.2	5.0	56.6	97.1	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Lip, oral cavity and pharynx (ABS 1997)	4.9	5.0	8.4	13.0	18.8	25.7	33.4	41.6	49.8	57.7	71.8	82.6	89.9
Digestive organs (C15-C26)	59.3	5.0	23.8	57.1	84.9	96.8	99.6	100.0	100.0	100.0	100.0	100.0	100.0
pancreas (C25)	9.0	5.0	9.9	17.3	27.0	38.3	50.2	61.7	71.9	80.3	91.5	96.8	99.0
liver (C22)	5.3	5.0	8.6	13.5	19.7	27.0	35.2	43.8	52.4	60.6	74.7	85.1	91.9
Melanoma (C43)	6.4	5.0	9.0	14.6	21.9	30.5	40.0	49.7	59.1	67.7	81.5	90.4	95.5
Brain (C71)	6.3	5.0	8.9	14.5	21.7	30.2	39.6	49.2	58.5	67.1	80.9	90.0	95.3
Prostate (C61)	28.7	5.0	15.9	35.1	58.2	78.0	90.6	96.7	99.0	99.8	100.0	100.0	100.0
Trachea, bronchus and lung (C33, C34)	48.0	5.0	21.0	49.7	77.6	93.2	98.6	99.8	100.0	100.0	100.0	100.0	100.0
Lymphatic and haematopoietic (C81-C96)	21.6	5.0	13.9	29.0	48.3	67.3	82.1	91.5	96.5	98.7	99.9	100.0	100.0
leukaemia CC91-C95)	8.1	5.0	9.6	16.4	25.3	35.7	46.8	57.8	67.9	76.5	88.8	95.3	98.3
Benign and unspecified (D00-D48)	4.2	5.0	8.1	12.2	17.4	23.4	30.2	37.5	44.9	52.3	66.0	77.2	85.6
All disease of circulatory system (I00-I99)	254.3	5.0	64.0	98.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
ischaemic heart disease	182.3	5.0	51.1	94.9	99.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Cerebrovascular disease (I60-I69)	53.2	5.0	22.3	53.2	81.3	95.2	99.2	99.9	100.0	100.0	100.0	100.0	100.0
Diseases of respiratory system (J00-J99)	64.0	5.0	25.0	59.9	87.3	97.7	99.8	100.0	100.0	100.0	100.0	100.0	100.0
Diseases of digestive system (K00-K93)	21.5	5.0	13.8	29.0	48.2	67.1	81.9	91.4	96.4	98.7	99.9	100.0	100.0
Diabetes (E10-E14)	16.9	5.0	12.5	24.9	41.0	58.1	73.3	84.7	92.1	96.3	99.4	99.9	100.0
Diseases of nervous system (G00-G99)	19.7	5.0	13.3	27.4	45.5	63.8	78.9	89.2	95.1	98.0	99.8	100.0	100.0
Accidents, poisoning and violence (V01-Y98)	58.4	5.0	23.6	56.5	84.4	96.6	99.5	100.0	100.0	100.0	100.0	100.0	100.0
All causes	710.1	5.0	98.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[a] For males per 100,000 per year. Source: Australian Bureau of Statistics, 2000.

Notes: Shaded area indicates where study power has less than 85% chance of detecting change in disease at the 0.05 level of significance

Assumptions:			
	Australian males	Number of individuals in comparison population (male)	9000000
	RAAF	Number of exposed participants in the study population	4438
		Length of time of follow-up of the study population (yrs)	34
		All participants traced	

Small Ships SQD — Estimated Power for Third Vietnam Veteran Mortality Study

Disease (ICD-10)	Standardised Death Rate[a]	% Probability of detecting changes in the relative risk of a given disease											
		Relative Risk (Ratio of change in disease incidence in study population)											
		1	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	2	2.2	2.4
All neoplasms (C00-D48)	215.4	5.0	16.5	37.0	61.3	81.1	92.7	97.8	99.5	99.9	100.0	100.0	100.0
Malignant neoplasms (C00-C97)	211.2	5.0	16.3	36.5	60.5	80.3	92.2	97.6	99.4	99.9	100.0	100.0	100.0
Lip, oral cavity and pharynx (ABS 1997)	4.9	5.0	6.1	7.3	8.6	10.0	11.5	13.1	14.8	16.6	20.3	24.2	28.3
Digestive organs (C15-C26)	59.3	5.0	9.6	16.4	25.3	35.8	47.0	58.1	68.2	76.8	89.0	95.5	98.4
pancreas (C25)	9.0	5.0	6.5	8.3	10.3	12.5	14.9	17.5	20.3	23.3	29.5	35.9	42.4
liver (C22)	5.3	5.0	6.1	7.4	8.8	10.3	11.9	13.6	15.4	17.3	21.3	25.4	29.8
Melanoma (C43)	6.4	5.0	6.3	7.7	9.2	11.0	12.8	14.8	16.9	19.1	23.8	28.7	33.7
Brain (C71)	6.3	5.0	6.2	7.6	9.2	10.9	12.7	14.7	16.8	18.9	23.5	28.4	33.4
Prostate (C61)	28.7	5.0	7.9	11.8	16.7	22.4	28.8	35.6	42.8	49.9	63.3	74.6	83.3
Trachea, bronchus and lung (C33, C34)	48.0	5.0	9.0	14.8	22.2	31.0	40.7	50.6	60.1	68.7	82.5	91.2	96.0
Lymphatic and haematopoietic (C81-C96)	21.6	5.0	7.5	10.7	14.5	19.0	24.0	29.5	35.3	41.2	52.9	63.7	73.1
leukaemia CC91-C95)	8.1	5.0	6.4	8.1	9.9	12.0	14.2	16.6	19.2	21.9	27.5	33.5	39.5
Benign and unspecified (D00-D48)	4.2	5.0	6.0	7.1	8.3	9.5	10.9	12.3	13.8	15.4	18.6	22.1	25.7
All disease of circulatory system (I00-I99)	254.3	5.0	18.1	41.8	68.1	86.9	96.0	99.1	99.8	100.0	100.0	100.0	100.0
ischaemic heart disease	182.3	5.0	15.1	32.8	54.7	74.6	88.2	95.5	98.5	99.6	100.0	100.0	100.0
Cerebrovascular disease (I60-I69)	53.2	5.0	9.3	15.6	23.7	33.3	43.7	54.1	64.0	72.7	85.8	93.5	97.4
Diseases of respiratory system (J00-J99)	64.0	5.0	9.9	17.1	26.6	37.7	49.5	60.9	71.1	79.6	91.1	96.7	98.9
Diseases of digestive system (K00-K93)	21.5	5.0	7.5	10.6	14.5	19.0	24.0	29.4	35.1	41.0	52.7	63.6	72.9
Diabetes (E10-E14)	16.9	5.0	7.2	9.8	13.0	16.7	20.8	25.2	30.0	34.9	44.9	54.7	63.7
Diseases of nervous system (G00-G99)	19.7	5.0	7.4	10.3	13.9	18.1	22.7	27.8	33.1	38.7	49.8	60.3	69.6
Accidents, poisoning and violence (V01-Y98)	58.4	5.0	9.6	16.3	25.1	35.4	46.5	57.5	67.6	76.2	88.6	95.3	98.3
All causes	710.1	5.0	38.6	84.7	98.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[a] For males per 100,000 per year. Source: Australian Bureau of Statistics, 2000.

Notes: Shaded area indicates where study power has less than 85% chance of detecting change in disease at the 0.05 level of significance

Assumptions: Australian males — Number of individuals in comparison population (male) 9000000

Small Ships — Number of exposed participants in the study population 596

Length of time of follow-up of the study population (yrs) 34

All participants traced

Naval Units — Estimated Power for Third Vietnam Veteran Mortality Study

Naval Unit	Number of personnel	RR for > 85% Power Mortality all causes (all neoplasms)	Merchant seamen	Total personnel	RR for > 85% Power Mortality all causes (all neoplasms)
BAND	20	2.3 (> 3.0)			
CDT3	49	1.8 (2.9)			
HELICOPTER FLIGHT VIETNAM	196	1.4 (1.8)			
HMAS *Anzac*	243	1.4 (1.8)			
HMAS *Boonaroo*	37	1.9 (> 3.0)	36	73	1.7 (2.5)
HMAS *Brisbane*	656	1.2 (1.5)			
HMAS *Derwent*	699	1.2 (1.4)			
HMAS *Duchess*	1,101	1.2 (1.4)			
HMAS *Hobart*	909	1.2 (1.4)			
HMAS *Jeparit*	139	1.5 (2.0)	239	378	1.3 (1.6)
HMAS *Melbourne*	1,492	1.2 (1.3)			
HMAS *Parramatta*	699	1.2 (1.4)			
HMAS *Perth*	861	1.2 (1.4)			
HMAS *Queenborough*	141	1.5 (2.0)			
HMAS *Quiberon*	148	1.5 (2.0)			
HMAS *Stuart*	318	1.3 (1.7)			
HMAS *Swan*	259	1.4 (1.7)			
HMAS *Sydney*	5,258	1.1 (1.2)			
HMAS *Torrens*	253	1.4 (1.7)			
HMAS *Vampire*	1,216	1.2 (1.3)			
HMAS *Vendetta*	989	1.2 (1.3)			
HMAS *Yarra*	818	1.2 (1.4)			
HQ AUSTRALIAN FORCE VIETNAM	14	2.5 (> 3.0)			
NO 9 SQN RAAF	7	> 3.0 (> 3.0)			
VISIT	355	1.3 (1.6)			
Total	*16,877*		*275*	*451*	

Notes: Assumptions: Vital Statistics available for all personnel; 34 years follow-up; Australian males comparison group; and ABS 2000 male standardised mortality rate

Army

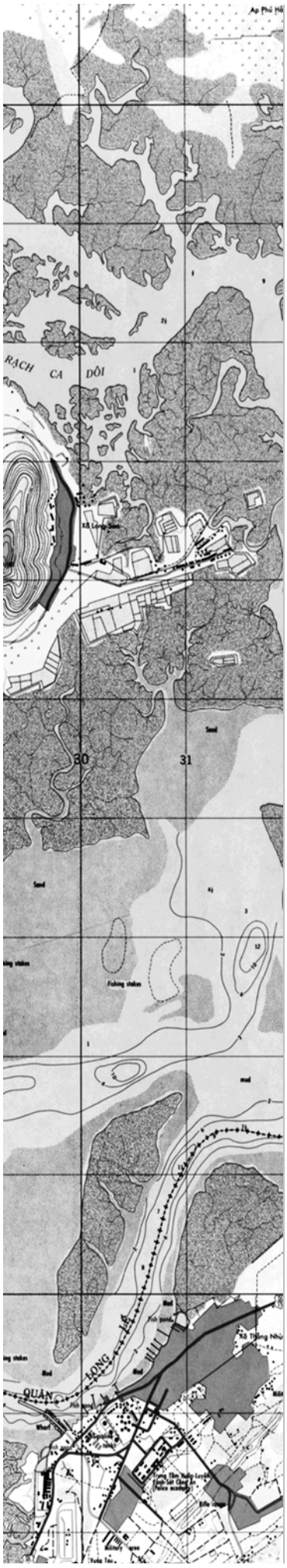
Power Calculations for Cancer Incidence

Disease (ICD-10)		Standardised Incidence	% Probability of detecting changes in the relative risk of a given disease							
			Relative Risk (Ratio of change in disease incidence in study population)							
			1	1.1	1.2	1.3	1.4	1.5	1.6	2
All neoplasms (C00-D48)	34.7	467.8	5.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Lung	6.9	56.9	5.0	87.3	100.0	100.0	100.0	100.0	100.0	100.0
Colorectal	182.3	65.8	5.0	91.2	100.0	100.0	100.0	100.0	100.0	100.0
Bladder	2.8	22.2	5.0	53.3	95.8	100.0	100.0	100.0	100.0	100.0
Pancreas (C25)	58.6	9.2	5.0	29.6	70.0	93.8	99.4	100.0	100.0	100.0
Kidney	9.5	14.3	5.0	39.7	85.6	99.0	100.0	100.0	100.0	100.0
Melanoma (C43)	2.4	47.2	5.0	81.2	100.0	100.0	100.0	100.0	100.0	100.0
Brain (C71)	8.1	7.5	5.0	26.0	62.3	89.0	98.2	99.8	100.0	100.0
Prostate (C61)	59.7	105.9	5.0	98.6	100.0	100.0	100.0	100.0	100.0	100.0
Non-Hodgkins	37.4	18.7	5.0	47.6	92.7	99.8	100.0	100.0	100.0	100.0
leukaemia CC91-C95)	28.5	13.0	5.0	37.3	82.5	98.4	100.0	100.0	100.0	100.0
Stomach	4.9	13.3	5.0	37.8	83.3	98.5	100.0	100.0	100.0	100.0

[a] For males per 100,000 per year. Source: Australian Bureau of Statistics, 2000.

Notes: Shaded area indicates where study power has less than 85% chance of detecting change in disease at the 0.05 level of significance

Assumptions:			
	Australia	Number of individuals in comparison population (male)	9000000
	Army	Number of exposed participants in the study population	41388
		Length of time of follow-up of the study population (years)	34
		All participants traced	



6

Perceptions of Service

Appendix C Perceptions of Service

Perceptions of Service

C.1. Introduction

This chapter explores the perceptions and recollections of Vietnam service of Navy and Army Small Ship personnel. The data is taken from transcripts of focus groups and notes from telephone interviews.

The study team was interested in obtaining background information on water distillation and usage on Navy and Army ships following the report *Examination of the potential exposure of Royal Australian Navy (RAN) personnel to polychlorinated dibenzodioxins and polychlorinated dibensofuans via drinking water*.[1] This report described the co-distillation of herbicides and pesticides in the evaporative distillation process used on ships to produce potable water. Discussions with veterans through focus groups were considered a productive means of obtaining first hand information on evaporative distillation processes on board Vietnam era ships. In addition to water issues, general conditions on board ships during the Vietnam conflict were of interest.

The DVA study team requested that the Consultative Forum members notify ESOs of the intention of a qualitative assessment of Navy and Army Small Ship conditions. Notification of DVA's interest in holding focus groups resulted in 61 Navy and 20 Army Small Ship veterans contacting the epidemiologist by phone or email. The epidemiologist interviewed the veterans by phone when a contact number was provided. Notes were taken and conversations documented. Focus groups were arranged when approximately 8 - 10 veterans from a capital city had expressed a willingness to participate. Four focus groups (two Navy groups with a total of 33 veterans and two Army Small Ships groups with a total of 14 veterans) in three capital cities were held between December 2002 and March 2003. Focus groups were audio-recorded and transcribed. Topics discussed in the focus groups are detailed in Appendices at the end of this paper.

It must be emphasised that the experiences and recollections detailed in this chapter are the memories and perceptions of the veterans. Some may remember events or procedures differently or documentation may present other details. This paper is the veterans' story and we have not attempted to reconcile or change any of the recollections to conform to published histories.

C.2. Navy Experience

C.2.1. Historical overview

Over 13,000 Navy personnel served in Vietnam between 1965 and 1972. It was not until 1986 that the majority of these veterans, approximately 10,000 Navy personnel who served on logistic support vessels, gained recognition of Vietnam service with the award of the 'Returned from Active Service Badge' and eligibility of repatriation benefits. A total of nineteen ships completed over one hundred voyages to Vietnam. For each voyage, the time in Vietnamese waters ranged from a day to several months.

C.2.2. Recollections of Navy service

C.2.2.1 Ship conditions

By today's standards life on board ships during the 1960's and 1970's was fairly arduous. The normal working routine was four hours on and eight hours off. If the eight hours off was during daylight hours the sailor often worked on other jobs as well. Some of the gunline ships conformed to the US Navy routine, which was four hours on and four hours off.

In the tropics the ships were very hot and ships were only partially air-conditioned. Some with an inside mess would sleep on deck because the cabins were too hot. In general, the Navy veterans felt air circulation was poor throughout the ships. Fresh air was forced in from wind chutes and out through the portholes or scuttles. Some veterans recall putting cheesecloth over the wind chute vents, especially if flies were coming in. Within two days the cheesecloth was "absolutely putrid". The engineers reported that freshest air was the boiler rooms due to the large fans which would force drive the air to help keep the boilers running.

In addition to the general heat of the tropics, specific jobs were done in very hot conditions. Working below decks for Ordinary Seamen could be oppressive.

> "most of the Ordinary Seamen were given the job of going down to the old ammunition lockers, which was about ten decks below [HMAS *Sydney*], and unloading all the Army boxes, for at least four hours' of shift down there. …the temperatures were unbelievable and we would drink at least five gallons of water between eight of us.

Engineers also worked in hot conditions. The machine rooms were sweltering and it was necessary to drink vast amounts of liquid. Coffee tins, which would hold about a gallon of limers or iced water, would be placed in the various machinery spaces. Everyone would drink out of the same tin. On HMAS *Sydney*, the engineers were entitled to a double beer ration for the conditions they worked under.

Heat in the working environment was also an issue for cooks. On HMAS *Sydney*, in particular, the galleys were in the old and very hot.

> "in the main galley… we took a thermometer in there one day and the temperature went up to 150, and that was just quite common up in the tropics"

Cooks also worked long hours and did not have the standard four on eight off shifts. Shifts were frequently twelve hours or longer. On HMAS *Sydney* and some of the gunline ships there was a proper meal every four hours. Before and after each meal the mess would be scrubbed out with fresh hot soapy water.

There was also no protection taken from the sun. Working on deck sailors wore shorts and sandals. Shirts generally were worn at dinner only and hats were impractical, as they would blow off. Sunscreen was not used in those days.

Asbestos was another hazard the veterans talked of experiencing on board ships. They recalled a fine white powder that was everywhere, in the bunks and bed sheets, and on benchtops. The cooks said that a white dust would come down over the food while they were cooking and they would just mix it in and serve it out. At the time they accepted this dust as part of life on ship. But in retrospect thought that the dust was probably due to the asbestos lagging throughout the ships.

> "we would walk along the food line and chunks of asbestos, this white asbestos garbage would get into everything."

> "Well, every time you fired a gun, you'd see a shower come down. You didn't know whether it was dust, asbestos or whatever it was. It would rain down on top of everything."

On HMAS *Sydney* asbestos curtains were used to isolate sections of the hanger deck as a fire control measure. They were sometimes used to darken areas of the hanger to enable movies to be shown in the late afternoon for the late shift. Once the curtains were lowered, everyone would have to wait for the dust to settle before starting the movie.

The veterans talked about the different types of asbestos in the different ships on which they served. They wondered if one type was less hazardous than another.

Diesel fumes and aviation gas fumes were frequently present on the ships. The later was especially dangerous as it affected ones sense of smell. Other fumes experienced on the ships include those from the funnel.

> "the funnel gases would just billow around and the poor officer would be breathing all this sulphuric noxious stuff which the engineers used to stick up the funnel."

This would also result in soot raining down which the medics would be "forever digging out of people's eyes". Other veterans talked about electronic emissions experienced on board ships. Some recall working very close to the large radar aerials without any special protection.

The veterans remembered how they were given a glass of milk following certain duties, such as scrubbing water tanks, welding and paint scraping. The theory at the time was that the fat in the milk would absorb and remove any lead or zinc from the lead based paint out of ones system.

Cigarette smoking was ubiquitous in the services. Cigarettes were cheap and cost about ten cents per pack and available readily from the canteen.

> "The rule was you weren't supposed to smoke pipes or cigars on decks, but people did. It didn't matter; it just went all through the air conditioning; it went through the whole ship and it would be in everything, in all your clothes, your bedding, your locker, and one of the

> things, when you took your towel and you headed for a shower, and once that towel was damp and you wiped your face, aaaaaaah! the smell of the cigarettes was bloody awful, real awful."

Cockroaches were a big problem on board the ships, especially in the galleys on HMAS *Sydney*. Numerous methods were used to try to control the problem. About every six months to one year the entire ship was closed down and fumigated. The sailors would take only some overnight clothes. The rest of their clothing, bedding and unopened food remained on board during the fumigation. No special precautions were taken to wipe down surfaces following fumigation. Fogging machines were also used which puffed out clouds of grey smoke. Cans of insecticide provided by the US military in plain khaki cans were used for spot spraying. Despite the extensive use of pesticides, the cockroach problem persisted.

> "Every army guy complained about his cockroach bites which he had continually."

> "There was one bloke I can remember and he said I'm going to sleep in the mess "I said "the cockies will annoy you" and he said "no, I'll sleep on this table"...I had to give him a shake in the morning, and he had cockroaches all over him, up his nose, in his ears …"

On the gunline ships (HMA ships *Brisbane*, *Hobart*, *Perth*, and *Vendetta*) the firing of the guns presented the veterans with a unique set of hazards. One gunner recalled that during his tour he worked very long hours and lifted tons of ammunition. During one especially busy time, he remembers that the guns fired for 50 hours non-stop. The veterans stated that in general the gunline ships fired 12,000 rounds every 6 months. While the guns were firing no one on board would be able to get much sleep. In addition many told of white dust, thought to be asbestos, raining down over all surfaces whenever the guns fired.

Few Navy personnel ever went on shore in Vietnam. While in Vung Tau Harbour the crews were very busy unloading and loading the ship. There was no time for any of the crew to have R & R. Leave was given in other ports such as Hong Kong or Subic Bay. The veterans remembered that the banks of the river were defoliated but none present could recall overhead spraying while they were in Vung Tau Harbour. However a veteran of HMAS *Vendetta* recalled seeing drifts of herbicide coming out to sea when they were in Da Nang Harbour.

C.2.2.2 Water distillation and usage

The veterans reported that the evaporators (water distillation plants on the ships) ran all the time to make water, including while at anchor in Vung Tau harbour. The prime objective of water distillation was to make feed water for the boilers. When these tanks were 95 or 98 percent full then the engineers would turn their attention to making drinking water (potable or ships tanks water).

> "being in the diving team, and going underneath the ship in Vung Tau, we could hear the machinery turning

> over. The only things that were really not turning were the propellers. That's about it."

The only time that water was definitely not distilled for potable water was in highly contaminated harbours, such as in Calcutta or Indonesian ports, where there was fear of microbial contamination. In these harbours water would still be distilled but used only for boilers (feed water) and not drinking or personal use. However one Warrant Officer engineer on the Sydney stated that it was strict policy not to take on water in Vung Tau and that after the troops left the ship the water requirements were not as great and thus they did not need to make water while in Vung Tau.

While in Vietnamese waters the ships were often in 'brown' water. The brown water from river run off would extend many kilometres out to sea.

> "You'd see the brown water before you saw the shoreline."

Gunline ships sailed within a kilometre and a half off shore, except when they replenished.

The evaporators on HMAS *Sydney* would make about one ton of water per hour. HMAS *Sydney* had three evaporators and the DDG's (HMA ships *Brisbane*, *Hobart* and *Perth*) had two evaporators. If the ship was in 'blue; water they could run the evaporators at 150-160 degrees Fahrenheit but if they were in dirty harbours where there was more of a risk of bacterial contamination then the evaporators would be run at 260-280 degrees. The higher temperature would lower the output of water.

The veterans discussed the different type of distilling system in the different ships. Some ships had electric coils "like a jug", others had steam coiled systems, still others had pressurised evaporators. HMAS *Hobart*, a new ship, had two flash chambers, which would distil water under pressure. All would make about a ton to one and one half tons of water per hour and about 30 - 40 tons per day. Engineers who worked on the English-style River Class Destroyers stated that the distillers were very efficient and could distil about two tons per hour. On the frigates and destroyers, tanks water would be rotated or replenished about every twelve hours. HMAS *Sydney* had a much larger storage capacity, about 400 tons, and the tanks would not be rotated as frequently. However when HMAS *Sydney* was carrying troops water was used much more quickly as Army personnel had no restrictions on their showers and other water usage.

Strict accounting of the water was done and if a shortage, top priority would be given to rectifying the situation.

> "What would happen then is if we consume a lot of water or those boilers had been leaking water in the close feed system, the Captain would get upset. He'd upset the engineer, then the engineer would come down and kick our backside. And then, instead of having our eight hours off, which we never had anyway during daylight hours…. you'd go through every system to find out where the water leak was. And the whole ship, as

> far as the engineering side, was driven by the amount of water used."

Besides the two main uses of water from the evaporators, that is, provision of steam for the boilers and potable drinking water, the evaporators provided water for many other tasks on board ships. Auxiliary saturated steam was used to clean the vehicles before they were loaded onto the HMAS *Sydney*. Steam was also used for the laundry.

However although water conservation was a way of life on a ship and sometimes showers were restricted, the veterans could not ever remember having too little water for drinking.

The main test carried out on the distilled water was using silver nitrate to test for salt content.

> "if you put three drops and there was no cloud, you had feed water; if you put one drop in and you had a slight cloud that was okay for fresh water. If it went white, you had to dump that and start again."

None of the veterans could recall other types of test for water purity being done.

C.2.2.3 Chemicals used in the water system

Storage tanks were well maintained. To stop scale build up in the entire water system the engineers would add chemicals to the water.

> ". I can't remember what they all were now, but I remember one was ferric chloride. It was metred into the water flow."

Others remember adding citric acid to the water to prevent the buildup of solids. Even so the machinery would have to be descaled every three or four weeks. Chlorine was only added to water that was obtained from the shore. This would be added on the doctor's advice.

When tanks were opened up for inspection they were covered in "browny yellow, greasey, slippery wet" coating. The sailors would use an anti-fouling emulsion in the tanks. They told how this solution would penetrate the skin and a single shower would not remove it. It would take a few days of scrubbing to remove it from the skin. The ships' tanks were emptied and cleaned with wire brushes. If the coating on the inside of the tanks started peeling (about once a year) then the tanks were painted inside with bitumastic paint. "It was like painting with tar." Some remember the name as 'Coraline Black'. The fumes from the paint made one dizzy and sailors could not stay in the tanks for more than thirty minutes at a time. By the end of the day they would have a splitting headache. Others told of tank inspections every 16 months and cleaning and repainting every 32 months. Other paint, which the veterans recalled being used in the early 1960s was a red lead powder, then Silvereen was used.

C.2.2.4 Food

Although the diet on board ships basically reflected the standards of the day, it was high in fat, sugar and salt. The excess salt came mainly from salt tablets, limers (a cordial type drink), and incomplete water evaporation.

> "(make up) the limers in the big ten gallon milk cans … there was no measurement, you just got this powder, put it in, and if, you know, you had a sweet tooth, so to speak, you made it strong, if you didn't, you made it weak, and salt tablets were taken like they were going out of fashion."

Besides limers, water and tea, the crew also drank soft drinks, which were made in a dispensing machine in which syrup, ship's water and carbonation was added. Some of the veterans remember that the water tasted 'funny – a bitter taste, which left your mouth feeling furry'.

Meals were meat and three vegetables. Everything was baked, fried or grilled in dripping. There were lots of stews and casseroles served. MSG was also used but there were no instructions on how much to use in cooking and the amounts varied greatly depending on the cook. When out at sea untreated sea water was used for cooking. Potatoes were peeled in a potato peeler machine, which used salt (ocean) water. After peeling, the potatoes would be stored in salt water and metasulphate solution until prepared for meals.

The quality and variety of the food also varied from ship to ship and was very dependent on the skill and ability of the vitaler. The US Navy supplied ships on the gunline. The Americans would supply these ships every second day with arms and fuel and about once a week with goods and mail. Many veterans remember the American supplied food as less palatable than that obtained from Australia. They especially hated the powdered and ether eggs, American sausages, turkey and too frequent mincemeat. However all enjoyed the American ice cream.

Although few navy personnel went onshore at Vung Tau, local foodstuffs were used to supply the ships. Tins of frozen milk, that was a rich mixture of buffalo and goat's milk was obtained and used to make iced coffee. Fresh vegetables in open boxes, such as carrots, green cauliflowers and cabbages, were brought onto the ships.

There were different experiences about fishing on board ships. It was generally agreed that on HMAS *Sydney*, sailors did not fish over the side. However on some of the other ships, the veterans do recall fishing but not generally in Vung Tau harbour. At Vung Tau there was too much activity around the ships, such as loading and unloading onto barges and navy divers underneath the ships, to allow for fishing. Others remembered fishing in Vung Tau and giving the caught fish to the cooks to prepare.

In conclusion, many of the veterans had joined up as ordinary seamen at young ages of 16 or 17. At that age a young man needs lots of food and sleep and the veterans felt that they just did not get enough of either. The work was physically demanding with many potential occupational hazards.

C.2.2.5 Record keeping

Each department would keep their own logbooks: sick bay, engineers, electricians, cooks and so on. A ship would have 10 to 15 different reports from the various departments being compiled every day. Other records on board ships were the monthly report of proceedings. These would tell the movement of the ship, what time it left harbour and what time it entered a harbour. Engineering reports were meticulously kept. Each piece of machinery would have a 24 hour log sheet.

> "What that report said, was how much water they'd consume from the boilers or lost from the closed central boiler system and how much they'd consume each day."

However although the everyday running of the ship was meticulously recorded, the veterans all agreed that embarrassing events were not recorded. Furthermore the veterans found that there were many errors in their personnel records when obtained from archives.

C.2.3. Summary of Navy recollections

Life on board Navy ships during the 1960's and early 1970's was basic and required stamina. Many personnel were still teenagers and their bodies still developing. For Navy veterans the time in Vietnam was generally a proportionally short time of their overall service.

C.3. 32 Small Ship Squadron

C.3.1. Historical overview

Water Transport units in the Australian Army were part of the Royal Australian Engineers Corps. These were first established during World War II as a means to supply the troops with tanks, heavy equipment and cargo on beachfronts and rivers. In 1960 the Army established the 32 Small Ship Squadron giving the Army amphibious capability to transport the Armoured Corps Centurion tanks.

Five ships made up the army small ship contingent during the Vietnam War. Four ships, the *Harry Chauvel*, *Brudenell White*, *Vernon Sturdee*, and *Clive Steele* were Landing Craft Medium (LSMs) built for the US Navy during WWII and bought by the Australian Army in 1959/60. The fourth ship, the *John Monash*, was a larger, 1200 ton coastal freighter purchased in 1965.

The LSMs were flat-bottomed ships specifically designed for coastal conditions. These ships sailed throughout the Vietnamese southern operational area but also to other Southeast Asian ports and New Guinea. They had a crew of about 40 men who generally did six-monthly rotations. The Squadron was disbanded in 1972 as the economic life of the ships had been reached.

C.3.2. Recollections of Army Small Ship service

Army 32 Small Ship Squadron tended to be a unit apart. It was a water based unit among a land based Army. Although the majority of the crew came from the RAE there were others that came from the signal corps, ordinance corps and medical corps. This unit also worked closely with the US military and in many areas was tasked exclusively by the Americans. These aspects tended to lead to increased mobility and flexibility compared to many other Australian Army units. For many it was a matter of pride and honour that an amphibious Army unit should supply the Army.

C.3.2.1 Ship conditions

The LSMs were built for short-term use landing supplies in the Pacific during World War II. As such the facilities for the crew were extremely basic. All accommodation spaces were below deck with poor ventilation with several sections of three tiered bunks in cramped and crowded conditions giving no room to roll over. The mess and sleeping area were combined.

> "If someone got out of bed where you were trying to eat your breakfast, they'd put their feet in your porridge."

Above the bunks were pipes lagged with asbestos, which would rain down on the sleeper during heavy seas, covering him in white dust. Toilet facilities were an open tray with a row of seats and no privacy.

The flat-bottomed ships did not travel well in rough seas.

> "They use to ride like a bloody pig….The thing would shake you to death."

When used during the Vietnam War, the LSMs were already old ships in need of constant maintenance. On the final trip of the *Clive Steele* in 1970 the bow doors fell off while approaching Sydney Harbour. Another veteran remembers the skipper putting his hand on the side of the ship and it went straight through the signals shaft.

The ships would deliver a wide assortment of supplies, from tanks, drums of fuel, ammunition to beer. For many areas in Vietnam, the LSMs were the only means of transporting heavy equipment to the troops as the roads and bridges were not suitable. The cargo hull was open and exposed to the elements. There were frequent problems with the cargo shifting in heavy seas.

The trips would vary in length. A trip from Vung Tau to Saigon would take a few hours whereas Vung Tau to the Mekong Delta would take14 hours. All the time they were up river or in the Delta, the crew were at stations.

Duties were varied among the small crew. Some, such as engineers, worked in shifts of four hours on eight hours off. However the maintenance requirements were high and it was not unusual that engineers and others worked very long days. Other crew were day workers who worked a normal day and they would help with other jobs as needed. However with a small crew duties were flexible and would change whether at sea or in port. While in port or in heavy seas all crew were needed, often for extended periods.

C.3.2.2 Leadership issues

Many of the veterans talked of leadership problems on board the Army Small Ships. The 32 Small Ship Squadron was raised for supplying tanks and other equipment to the troops in Vietnam along the costal and river system. However the Army at the time had a shortage of master mariners and had to recruit from a variety of sources such as merchant mariners and the British Navy. Many of the captains were not familiar with Army routine or the Australian culture which lead to some dissension between the other ranks and officers. The veterans acknowledged that some of the captains were fine leaders but others were not well-liked or respected by the other ranks.

The veterans stated that the majority of skippers were transient. They would complete one six month trip and then leave whereas the crew members often would do several tours.

> "Those guys would do their one trip, go home and they'd send another one; they'd never been in command before; they knew nothing about the military and apart from two, the rest of them were a load of rubbish."

> "They had zero experience in command of anything, let alone the dinghy that went ashore….We were faced with those types of people in the leadership role."

C.3.2.3 Food and Drink

Food was obtained from a variety of sources, generally from American or Australian suppliers. Fresh local food was also obtained from the Vietnamese, especially when away from Vung Tau. Some recalled the practice that Friday night in Vung Tau was beer and prawn night. However many said they did not eat locally prepared food as many had suffered illness when they had eaten from local food stalls. Others fondly remember the Vietnamese bread. Many commented that they did not care for the American food as it was so different from what they were use to and there was unanimous distaste for the ether eggs.

Limers were not generally made up on the Small Ships, unlike in the Navy. The crew tended to drink water or cans of soft drinks, tea and coffee.

The recollections about drinking of alcohol on board the small ships varied. Many maintained there was ration at sea of two cans of beer per day for each of the crew. However this seemed to vary between individual ships and skippers. When in Vietnam and New Guinea there wasn't drinking on board as "You got enough of it on shore". Others maintained that there was some heavy drinking occurring and the beer was unlimited, "Some would drink all night. Eight cents per can.".

C.3.2.4 Water distillation and usage

The LSMs had a Kleinschmidt water distillation unit that would distil about 100 gallons of potable water per day. The ship had a storage capacity of about 17 and one half tons and it was estimated three tons were used per day. The engineers remarked

that running the unit would cause the temperature in the engine room to increase to extremely uncomfortable levels.

> "Once that thing was turned on, it became a sweat bath."

The distillation unit was only used on longer trips out at sea. When in harbour fresh water was pumped on board. The source of the fresh water varied depending on the port. Generally water was obtained from Australian or American organisations but sometimes it was obtained from local Vietnamese and then the crew would add buckets of chlorine to the supply.

C.3.2.5 Chemicals in the environment

The veterans talked of extensive herbicide spraying along the riverbanks. They recalled how they would sail past lush thick jungle and return a few weeks later to see "barren brown mudflats" for 100 meters along the banks. They marvelled at the way the herbicide turned the lush jungle into mush.

> "It was like you've left lettuce in the corner of the kitchen in a plastic bag and forgotten about it. And you know how it goes to slime and mush."

Fogging for mosquitoes was also frequently done. At the time the soldiers were not overly concerned about the spraying.

> "See we don't know whether they were spraying for mozzies or defoliage, or what. We just accepted things."

Cockroaches were a big problem and the ships would be fumigated every six months. Diesel fumes and cigarette smoke was ubiquitous.

The water tanks were painted with a sealant called tarapoxy which "could knock you over when you went into the tank". Others talked of rubbing white lead over cables to stop rust. Ship divers would melt their own lead weights and remarked that the lead lay on their bare skin for days.

C.3.2.6 Record keeping

When the ships became decommissioned many of the records were lost. Some were taken by individuals for souvenirs, others were simply thrown in a rubbish tip or burnt. Many of the surviving log books suffered extensive water damage.

There was general consensus among the veterans that even if those records had survived they would only tell part of the story. The completeness of record keeping varied from ship to ship and captain to captain.

C.3.3. Summary of 32 Small Ship Squadron recollections

The experiences of veterans of the 32 Small Ship Squadron were unique. They were a water based Army unit, frequently under the instructions of the Americans, working on aging ships under sometimes difficult leadership. As a small unit working throughout the operational area and Southeast Asia, they generally were more mobile than many other Army units and had more flexibility than Navy crews.

C.4. Conclusions

This series of focus groups were initiated to obtain a better understanding of the experiences on board ships serving in the Vietnam operational area. The emphasis on the ship environment was in response to previous studies which indicated a potential for exposure to dioxin contaminated potable water and a higher than expected mortality of Navy personnel.[1, 2]

Specifically, water distillation procedures and water usage were of interest as well as general life conditions and exposure to any hazards that may contribute to long term health consequences. Life on board Navy and Army ships was basic and arduous. However the men were young and fit and generally at the time saw their experience as an adventure.

For Navy vessels, water distillation occurred in Vietnamese waters and in the tropical conditions there was a large consumption of this potable water by personnel in their food and drink. The men were exposed to numerous occupational hazards common to the Navy conditions at the time but the extent and nature of these exposures varied by the ship on which they served.

Army small ships sourced their water mainly from shore while in the Vietnamese operational area, while distillation procedures were reserved for longer ocean voyages. The veterans' exposure to the land and water based Vietnamese environment was extensive. The structure of the unit presented unique advantages and disadvantages. The ships were aged and not built for the conditions in which they served but served a vital role in supplying the troops where roads were few and poor.

References

1. Muller J, Gaus C, Alberts V, Moore M. Examination of the potential exposure of Royal Australian Navy (RAN) personnel to polychlorinated dibenzodioxins and polychlorinated dibensofurans via drinking water. Canberra: National Research Centre for Environmental Toxicology, Department of Veterans' Affairs, 2002:75.

2. Crane P, Barnard D, Horsley K, Adena M. Mortality of national service Vietnam veterans: A report of the 1996 retrospective cohort study of Australian Vietnam veterans. Canberra: Department of Veterans Affairs, 1997:90.

Focus Group RAN veterans

Topics for Discussion

Introduction

- Thank them for coming
- Reiterate purpose of FG.
- Introduce DVA people.
- Explain the process.
- Ask permission to audio-record the session. Assure no people identified.

1) Many of you were on the HMAS Sydney but others were on the Vampire, Perth, Supply, Yarra, Parramatta, Vendetta, Queenborough and you all held different types of jobs though many were engineers or cooks. We would like to get an idea of what an average day was like on board ship. We thought we could go around the group and you could talk us through a typical day from when you got up to when you went to bed. (start off with time out at sea and by job group)

(25 minutes)

Prompts: What were the Ship's routines?
What type of food did you eat?
What did you drink during the day?
How frequently could you shower?
How much 'down' time did you get?

(if time) *What was involved in replenishment at sea?*
Did it include fuel and food, ammunition?

2) How did the "typical" day differ in port from that out at sea?

(20 minutes)

Prompts: What ports did you anchor? How often and how long in port?
How frequently did you get shore leave? How long was it?
Did you eat the local food? How much and how often?
Did you catch fish for food?

(If time) *What kind of maintenance work was done?*
Terms to clarify if time:
Fleet maintenance Party

Ships Staff, Coolie Labour

Ships husbandry, fitting out wharf

mid cycle docking period

long self maintenance, refit

dockyard planned maintenance

3) For the engineers: Could you describe the water distillation procedures and your typical job routines?

(10 minutes)

Prompts: Was water taken on from the harbour/River area?

How frequently did you distil?

Water for drinking vs that for boilers?

Volume of water distilled?

Probes: How frequently did you need to do maintenance?

Did you need to scrub out the boilers?

Prompts: How was this done?

Were solvents or chemicals used in the process?

How much? What kinds?

Probes: What make of distiller did you use?

4) For the Cooks: What type of food did you cook and how did you cook it and your other typical duties?

(10 minutes)

Prompts: From where did you obtain food supplies?

What was the quality?

Were different meals prepared in different galleys?

How many galleys were they? Did this vary between types of ships?

Probe: Do you recall any illness attributed to food?

Prompts: Diarrhoea? Vomiting? Skin Rashes?

5) Some of the sailors I have talked to mentioned cockroach and other pest problems. What is your recollection?

(10 minutes)

Probes: Was the problem throughout the ship or localised to eating/food areas?

What was done to control this?

6) Besides the topics we have already discussed (water, food and pests) were there other conditions on the ships that may have caused concern?

(5 minutes)

Prompts: Asbestos?

Fuel fumes?

7) Beth and Cherrie are busy finding primary sources of information from the archives but are finding the documentation a bit variable. What are your recollections on the procedures for record keeping?

(5 minutes)

Prompts: What types of records were kept very carefully?

What types of records were with less care?

8) The nominal roll seems to have a reasonable capture of those sailors assigned to different ships in Vietnam but we would like to get a sense of how reliable this information is. How frequently did crew members change ships?

(5 minutes)

Prompts: What type of turnover?

How carefully were records kept of changes?

What were the reasons for transfer?

Focus Group 32 Small Ship Squadron veterans

Topics for Discussion

Introduction

- Thank them for coming
- Reiterate purpose of FG.
- Introduce DVA people.
- Explain the process.
- Ask permission to audio-record the session. Assure no people identified.

1) All of you served in the 32 Small Ship Squadron and you all held different types of jobs. We would like to get an idea of what an average day was like on board ship. We thought we could go around the group and you could talk us through a typical day from when you got up to when you went to bed. We understand that the John Monash was a bit different from the other smaller four ships so could you please identify on which ship you served and your job on board.

(25 minutes)

Prompts: What were the Ship's routines?
How much 'down' time did you get?

2) You were logistic support vessels. What type of cargo did you carry?

(15 minutes)

Prompt: Did you carry herbicides?
What condition were the drums?
Probes: Where did you take these supplies?
Where you involved in any action?

3) Could you describe the water distillation procedures and your typical job routines?

(20 minutes)

Prompts: How frequently were the water distillation plants run?

Probes: When was potable water taken on board from shore?
What was its source?

Probes: How frequently was untreated river/harbour water used ?

Prompts: Cleaning, showering, cleaning potatoes, swimming, laundry?

4) Tell us about the food and drink you consumed?

(15 minutes)

Prompts: What did you drink? – water? Limers? Beer?
Did you eat local foodstuffs? – Fishing, shellfish

Probe: Do you recall any illness attributed to food?

Prompts: Diarrhoea? Vomiting? Skin Rashes?

5) Were there people from other units detached to the ships?

(15 minutes)

Prompts: Was this a normal occurrence?

How long were they attached?

Are there any documents detailing these detachments?

Probes: Aside from the logs and ledgers that were kept on board each ship, did you have to send regular reports to a land-based unit?

What types of reports? How often?

Which unit where they sent to?"

6) Besides the topics we have already discussed (water and food) were there other conditions on the ships that may have caused concern?

(15 minutes)

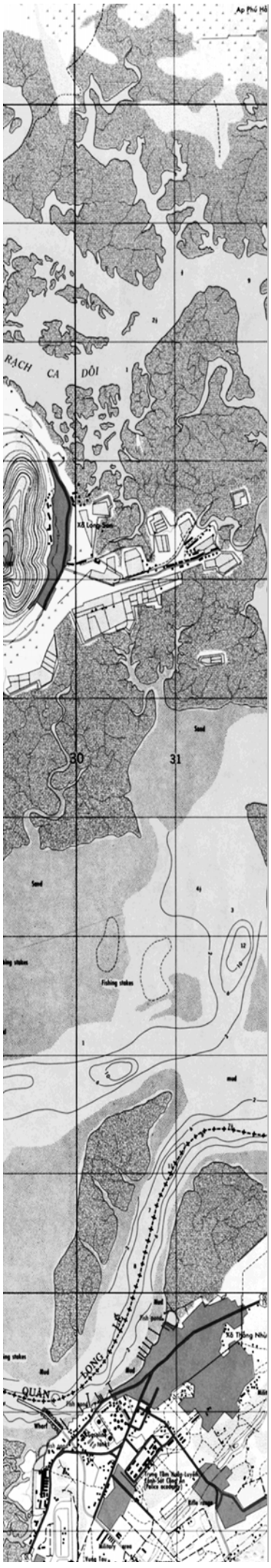
Prompts: Cockroaches?

Asbestos?

Fuel fumes?

Living quarters?

Morale?



D

Tables of Results

Appendix D Tables of Results

Table D1: All Service branches, Vietnam veterans: Observed and expected number of deaths, and standardised mortality ratios (SMRs).

		Scenario 1 (excluding veterans whose status is unknown)			Scenario 2 (including veterans whose status is unknown)			
Cause of death	**Observed**	**Expected**	**SMR**	**95% CI**	**Expected**	**SMR**	**95% CI**	**Period**
All deaths	6,166	6,529	0.94	0.92-0.97	6,690	0.92	0.90-0.94	1963-2001
Infectious and parasitic diseases excluding Aids	33	53	0.62	0.41–0.83	55	0.6	0.40-0.81	1963-2001
Aids	39	49	0.79	0.54–1.03	50	0.77	0.53-1.01	1988-2001
Tuberculosis	5	6	0.86	0.26–1.89	6	0.84	0.26-1.85	1963-2001
Neoplasms	2,058	1,938	1.06	1.02–1.11	1,988	1.03	0.99-1.08	1963-2001
Blood & blood organs	12	14	0.88	0.44–1.50	14	0.85	0.43-1.46	1968-2001
Endocrine, nutritional and metabolic diseases	94	151	0.62	0.49–0.74	155	0.6	0.48-0.72	1963-2001
Diabetes	55	106	0.52	0.38–0.66	109	0.5	0.37-0.64	1963-2001
Mental disorders	51	83	0.61	0.45–0.78	85	0.6	0.43-0.76	1968-2001
Nervous system	91	117	0.78	0.62–0.94	120	0.76	0.60-0.91	1968-2001
Multiple sclerosis	5	8	0.67	0.22–1.55	8	0.66	0.21-1.52	1963-2001
Motor neurone	25	24	1.06	0.64–1.47	25	1.03	0.63-1.43	1963-2001
Eye diseases	0	0	0.00	0.00–58.01	0	0	0.0-56.75	1963-2001
Ear diseases	1	1	2.02	0.05–11.10	1	1.98	0.05-10.9	1963-2001
Circulatory system	1,767	2,008	0.88	0.84–0.92	2,061	0.86	0.82-0.90	1963-2001
Ischaemic	1,297	1,384	0.94	0.89–0.99	1,420	0.91	0.86-0.96	1963-2001
Cerebrovascular	223	278	0.80	0.70–0.91	286	0.78	0.68-0.88	1963-2001
Respiratory system	239	311	0.77	0.67–0.87	320	0.75	0.65-0.84	1963-2001
Asbestosis	3	2	1.77	0.36–5.11	2	1.72	0.35-4.94	1979-2001
COPD	128	150	0.85	0.70–1.00	155	0.82	0.68-0.97	1979-2001
Respiratory excluding COPD	105	121	0.87	0.70–1.03	124	0.84	0.68-1.00	1979-2001
Digestive system	292	283	1.03	0.91–1.15	290	1.01	0.89-1.12	1968-2001
Liver, gall bladder and bile ducts	220	203	1.09	0.94–1.23	207	1.06	0.92-1.20	1968-2001
Alcoholic liver	161	135	1.19	1.01–1.38	138	1.17	0.99-1.35	1968-2001
Peptic ulcer	12	23	0.55	0.27–0.93	23	0.53	0.27-0.90	1968-2001
Skin and subcutaneous tissue	3	4	0.76	0.15–2.20	4	0.74	0.15-2.13	1968-2001
Musculoskeletal system	10	17	0.61	0.29–1.10	17	0.59	0.28-1.07	1968-2001
Genitourinary system	30	45	0.66	0.42–0.90	46	0.64	0.41-0.87	1968-2001
Congenital malformation	6	25	0.24	0.09–0.52	26	0.24	0.09-0.51	1968-2001
Ill defined	23	30	0.74	0.43–1.05	31	0.73	0.43-1.03	1968-2001
External chapter	1,394	1,390	1.00	0.95–1.06	1,417	0.98	0.93-1.04	1963-2001
Assault	31	55	0.56	0.36–0.76	56	0.55	0.35-0.74	1963-2001
MVA	553	535	1.03	0.95–1.12	545	1.02	0.93-1.10	1963-2001
Suicide	421	410	1.03	0.93–1.13	418	1.01	0.91-1.10	1963-2001
Firearms	123	117	1.05	0.87–1.24	119	1.03	0.85-1.22	1963-2001
Gas and vapours	134	97	1.38	1.15–1.61	99	1.35	1.12-1.58	1963-2001
Hanging	72	78	0.93	0.72–1.15	79	0.92	0.70-1.13	1963-2001

Table D2: Navy Vietnam veterans: Observed and expected number of deaths, and standardised mortality ratios (SMRs).

		Scenario 1 (excluding veterans whose status is unknown)			Scenario 2 (including veterans whose status is unknown)			
Cause of death	**Observed**	**Expected**	**SMR**	**95% CI**	**Expected**	**SMR**	**95% CI**	**Period**
All deaths	1,435	1,430	1.00	0.95–1.06	1,474	0.97	0.92–1.02	1963-2001
Infectious and parasitic diseases excluding Aids	10	12	0.85	0.40–1.55	12	0.83	0.39–1.50	1963-2001
Aids	10	11	0.89	0.42–1.63	12	0.87	0.41–1.59	1988-2001
Tuberculosis	2	1	1.28	0.02–4.14	1	1.25	0.02–4.02	1963-2001
Neoplasms	491	413	1.19	1.08–1.29	426	1.15	1.05–1.25	1963-2001
Blood & blood organs	4	3	1.34	0.36–3.38	3	1.30	0.35–3.28	1968-2001
Endocrine, nutritional and metabolic diseases	23	32	0.72	0.43–1.02	33	0.70	0.42–0.99	1963-2001
Diabetes	12	22	0.54	0.28–0.94	23	0.53	0.27–0.91	1963-2001
Mental disorders	9	19	0.48	0.22–0.89	20	0.46	0.21–0.87	1968-2001
Nervous system	17	25	0.68	0.39–1.07	26	0.66	0.38–1.04	1968-2001
Multiple sclerosis	3	2	1.87	0.38–5.40	2	1.82	0.37–5.25	1963-2001
Motor neurone	1	5	0.20	0.00–1.08	5	0.19	0.00–1.05	1963-2001
Eye diseases	0	0	0.00	0.0–223.14	0	0.00	0.00–217.4	1963-2001
Ear diseases	1	0	8.38	0.21–46.23	0	8.16	0.20–45.02	1963-2001
Circulatory system	399	423	0.94	0.85–1.04	437	0.91	0.82–1.00	1963-2001
Ischaemic	282	291	0.97	0.86–1.08	301	0.94	0.83–1.05	1963-2001
Cerebrovascular	55	58	0.94	0.69–1.19	60	0.91	0.67–1.15	1963-2001
Respiratory system	50	65	0.76	0.55–0.97	67	0.74	0.53–0.94	1963-2001
Asbestosis	1	0	2.95	0.07–16.27	0	2.83	0.07–15.59	1979-2001
COPD	28	30	0.94	0.59–1.28	31	0.90	0.57–1.23	1979-2001
Respiratory excluding COPD	19	26	0.75	0.45–1.16	26	0.73	0.43–1.12	1979-2001
Digestive system	63	61	1.03	0.77–1.28	63	1.00	0.75–1.24	1968-2001
Liver, gall bladder and bile ducts	43	44	0.97	0.68–1.26	45	0.94	0.66–1.22	1968-2001
Alcoholic liver	30	29	1.03	0.66–1.40	30	1.00	0.65–1.36	1968-2001
Peptic ulcer	4	5	0.85	0.23–2.14	5	0.82	0.22–2.07	1968-2001
Skin and subcutaneous tissue	0	1	0.00	0.00–4.45	1	0.00	0.00–4.30	1968-2001
Musculoskeletal system	2	3	0.58	0.07–2.08	4	0.56	0.07–2.01	1968-2001
Genitourinary system	6	9	0.65	0.24–1.40	10	0.63	0.23–1.35	1968-2001
Congenital malformation	2	6	0.35	0.04–1.23	6	0.34	0.04–1.20	1968-2001
Ill defined	6	7	0.87	0.32–1.88	7	0.85	0.31–1.83	1968-2001
External chapter	340	335	1.02	0.91–1.12	343	0.99	0.89–1.10	1963-2001
Assault	10	13	0.80	0.38–1.44	13	0.78	0.37–1.41	1963-2001
MVA	138	135	1.02	0.85–1.19	138	1.00	0.83–1.16	1963-2001
Suicide	97	95	1.01	0.81–1.22	98	0.99	0.79–1.19	1963-2001
Firearms	22	27	0.81	0.47–1.15	28	0.79	0.46–1.12	1963-2001
Gas and vapours	37	22	1.63	1.10–2.16	23	1.59	1.08–2.11	1963-2001
Hanging	19	18	1.06	0.63–1.63	19	1.03	0.61–1.59	1963-2001

Table D3: Army Vietnam veterans: Observed and expected number of deaths, and standardised mortality ratios (SMRs).

		Scenario 1 (excluding veterans whose status is unknown)			Scenario 2 (including veterans whose status is unknown)			
Cause of death	**Observed**	**Expected**	**SMR**	**95% CI**	**Expected**	**SMR**	**95% CI**	**Period**
All deaths	4,045	4,348	0.93	0.90–0.96	4,444	0.91	0.88–0.94	1963-2001
Infectious and parasitic diseases excluding Aids	19	36	0.54	0.32–0.83	37	0.53	0.31–0.81	1963-2001
Aids	28	35	0.82	0.52–1.12	36	0.80	0.51–1.09	1988-2001
Tuberculosis	2	4	0.57	0.06–1.80	4	0.56	0.06–1.76	1963-2001
Neoplasms	1,323	1,281	1.03	0.98–1.09	1,311	1.01	0.95–1.06	1963-2001
Blood & blood organs	7	9	0.76	0.30–1.55	10	0.75	0.29–1.51	1968-2001
Endocrine, nutritional and metabolic diseases	60	101	0.59	0.44–0.74	103	0.58	0.43–0.73	1963-2001
Diabetes	37	70	0.52	0.35–0.69	72	0.51	0.34–0.67	1963-2001
Mental disorders	38	56	0.68	0.46–0.89	57	0.66	0.45–0.87	1968-2001
Nervous system	60	79	0.76	0.57–0.95	81	0.74	0.55–0.93	1968-2001
Multiple sclerosis	2	5	0.39	0.05–1.40	5	0.38	0.05–1.37	1963-2001
Motor neurone	18	16	1.14	0.67–1.77	16	1.11	0.65–1.73	1963-2001
Eye diseases	0	0	0.00	0.00–98.30	0	0.00	0.00–96.21	1963-2001
Ear diseases	0	0	0.00	0.00–10.96	0	0.00	0.00–10.77	1963-2001
Circulatory system	1,136	1,316	0.86	0.81–0.91	1,348	0.84	0.79–0.89	1963-2001
Ischaemic	854	906	0.94	0.88–1.01	927	0.92	0.86–0.98	1963-2001
Cerebrovascular	128	182	0.70	0.58–0.83	187	0.69	0.57–0.81	1963-2001
Respiratory system	162	202	0.80	0.68–0.92	207	0.78	0.66–0.90	1963-2001
Asbestosis	2	1	1.86	0.22–6.61	1	1.81	0.22–6.42	1979-2001
COPD	81	96	0.85	0.67–1.03	98	0.83	0.65–1.00	1979-2001
Respiratory excluding COPD	77	81	0.96	0.75–1.17	83	0.94	0.73–1.14	1979-2001
Digestive system	197	190	1.04	0.89–1.18	194	1.01	0.87–1.16	1968-2001
Liver, gall bladder and bile ducts	154	136	1.13	0.95–1.31	139	1.11	0.93–1.28	1968-2001
Alcoholic liver	112	91	1.23	1.00–1.45	93	1.20	0.98–1.43	1968-2001
Peptic ulcer	7	15	0.49	0.19–0.98	15	0.48	0.19–0.96	1968-2001
Skin and subcutaneous tissue	1	3	0.38	0.01–2.09	3	0.37	0.01–2.03	1968-2001
Musculoskeletal system	7	11	0.65	0.26–1.31	11	0.63	0.25–1.28	1968-2001
Genitourinary system	18	30	0.62	0.36–0.96	30	0.60	0.35–0.93	1968-2001
Congenital malformation	3	17	0.18	0.04–0.51	18	0.17	0.04–0.50	1968-2001
Ill defined	13	21	0.64	0.33–1.07	21	0.63	0.33–1.05	1968-2001
External chapter	954	955	1.00	0.94–1.06	971	0.98	0.92–1.04	1963-2001
Assault	20	38	0.53	0.30–0.76	39	0.52	0.30–0.75	1963-2001
MVA	382	365	1.05	0.94–1.15	371	1.03	0.93–1.13	1963-2001
Suicide	293	283	1.04	0.92–1.15	288	1.02	0.90–1.13	1963-2001
Firearms	92	81	1.15	0.91–1.38	82	1.13	0.90–1.36	1963-2001
Gas and vapours	87	68	1.28	1.01–1.55	69	1.26	0.99–1.52	1963-2001
Hanging	48	53	0.90	0.64–1.15	54	0.88	0.63–1.13	1963-2001

Table D4: Air Force Vietnam veterans: Observed and expected number of deaths, and standardised mortality ratios (SMRs).

		Scenario 1 (excluding veterans whose status is unknown)			Scenario 2 (including veterans whose status is unknown)			
Cause of death	**Observed**	**Expected**	**SMR**	**95% CI**	**Expected**	**SMR**	**95% CI**	**Period**
All deaths	686	753	0.91	0.84–0.98	773	0.89	0.82–0.95	1963-2001
Infectious and parasitic diseases excluding Aids	3	6	0.55	0.11–1.58	6	0.54	0.11–1.54	1963-2001
Aids	0	3	0.00	0.00–1.23	3	0.00	0.00–1.21	1988-2001
Tuberculosis	1	1	1.24	0.03–6.94	1	1.21	0.03–6.76	1963-2001
Neoplasms	245	244	1.00	0.88–1.13	251	0.97	0.85–1.10	1963-2001
Blood & blood organs	1	2	0.63	0.02–3.45	2	0.62	0.02–3.35	1968-2001
Endocrine, nutritional and metabolic diseases	10	18	0.56	0.26–1.01	19	0.54	0.25–0.98	1963-2001
Diabetes	6	13	0.46	0.17–0.98	14	0.45	0.16–0.95	1963-2001
Mental disorders	4	8	0.49	0.13–1.23	9	0.48	0.13–1.20	1968-2001
Nervous system	14	12	1.11	0.56–1.79	13	1.08	0.54–1.74	1968-2001
Multiple sclerosis	0	1	0.00	0.00–5.04	1	0.00	0.00–4.94	1963-2001
Motor neurone	6	3	2.14	0.77–4.54	3	2.08	0.74–4.42	1963-2001
Eye diseases	0	0	0.00	0.0–386.71	0	0.00	0.00–380.5	1963-2001
Ear diseases	0	0	0.00	0.00–82.20	0	0.00	0.00–80.49	1963-2001
Circulatory system	234	268	0.87	0.76–0.98	276	0.85	0.74–0.95	1963-2001
Ischaemic	161	187	0.86	0.73–0.99	193	0.84	0.71–0.97	1963-2001
Cerebrovascular	40	38	1.07	0.74–1.40	39	1.04	0.72–1.36	1963-2001
Respiratory system	28	44	0.64	0.40–0.88	45	0.62	0.39–0.85	1963-2001
Asbestosis	0	0	0.00	0.00–13.07	0	0.00	0.00–12.56	1979-2001
COPD	18	24	0.76	0.44–1.17	25	0.73	0.42–1.13	1979-2001
Respiratory excluding COPD	8	15	0.55	0.24–1.06	15	0.53	0.23–1.03	1979-2001
Digestive system	33	33	1.02	0.67–1.36	33	0.99	0.65–1.33	1968-2001
Liver, gall bladder and bile ducts	25	22	1.12	0.68–1.55	23	1.09	0.66–1.52	1968-2001
Alcoholic liver	20	14	1.38	0.81–2.09	14	1.35	0.79–2.05	1968-2001
Peptic ulcer	1	3	0.33	0.01–1.78	3	0.32	0.01–1.73	1968-2001
Skin and subcutaneous tissue	2	0	4.16	0.49–14.67	1	4.02	0.48–14.19	1968-2001
Musculoskeletal system	1	2	0.47	0.01–2.57	2	0.46	0.01–2.49	1968-2001
Genitourinary system	6	6	0.94	0.27–1.97	6	0.91	0.26–1.90	1968-2001
Congenital malformation	1	2	0.51	0.01–2.75	2	0.50	0.01–2.70	1968-2001
Ill defined	3	3	1.22	0.23–3.26	3	1.20	0.23–3.20	1968-2001
External chapter	98	101	0.97	0.78–1.16	103	0.95	0.76–1.14	1963-2001
Assault	0	4	0.00	0.00–0.92	4	0.00	0.00–0.90	1963-2001
MVA	30	35	0.87	0.56–1.18	35	0.86	0.55–1.16	1963-2001
Suicide	31	31	0.98	0.64–1.33	32	0.97	0.63–1.31	1963-2001
Firearms	9	9	0.93	0.39–1.71	9	0.91	0.38–1.69	1963-2001
Gas and vapours	11	7	1.54	0.68–2.60	7	1.52	0.67–2.56	1963-2001
Hanging	5	6	0.85	0.27–1.93	6	0.83	0.26–1.89	1963-2001

Table D5: All Service branches, Vietnam veterans: Observed and expected number of cancer deaths, and standardised mortality ratios (SMRs).

		Scenario 1 (excluding veterans whose status is unknown)			Scenario 2 (including veterans whose status is unknown)			
Cause of death	**Observed**	**Expected**	**SMR**	**95% CI**	**Expected**	**SMR**	**95% CI**	**Period**
All neoplasms	2,058	1,938	1.06	1.02–1.11	1,988	1.03	0.99–1.08	1963-2001
Brain and CNS	99	105	0.95	0.76–1.13	107	0.92	0.74–1.11	1963-2001
Breast	4	2	2.15	0.58–5.42	2	2.10	0.56–5.28	1963-2001
Connective soft tissue	12	16	0.75	0.38–1.28	17	0.73	0.37–1.25	1968-2001
Eye	6	2	2.79	1.00–5.94	2	2.72	0.98–5.79	1963-2001
Gastrointestinal	329	343	0.96	0.86–1.06	352	0.94	0.83–1.04	1968-2001
Colorectal	248	257	0.96	0.84–1.08	263	0.94	0.82–1.06	1963-2001
Colon	176	180	0.98	0.83–1.12	185	0.95	0.81–1.10	1963-2001
Rectum	69	76	0.92	0.70–1.13	77	0.89	0.68–1.10	1963-2001
Stomach	76	81	0.94	0.73–1.15	83	0.91	0.71–1.12	1963-2001
Genitourinary	197	188	1.04	0.90–1.19	194	1.01	0.87–1.16	1968-2001
Bladder	22	31	0.71	0.42–1.01	32	0.69	0.40–0.98	1963-2001
Kidney	50	53	0.95	0.68–1.21	54	0.92	0.67–1.18	1963-2001
Prostate	107	87	1.23	0.99–1.46	90	1.18	0.96–1.41	1963-2001
Testis	14	16	0.85	0.43–1.39	16	0.83	0.43–1.37	1963-2001
Hodgkin's disease	13	15	0.89	0.46–1.49	15	0.88	0.46–1.46	1963-2001
Leukaemia	84	79	1.07	0.84–1.30	81	1.04	0.82–1.27	1963-2001
Lymphoid leukaemia	24	20	1.20	0.72–1.67	21	1.17	0.70–1.63	1968-2001
Myeloid leukaemia	55	53	1.05	0.77–1.32	54	1.02	0.75–1.29	1968-2001
Liver and gallbladder	48	54	0.88	0.63–1.13	56	0.86	0.62–1.10	1963-2001
Lung	544	462	1.18	1.08–1.28	474	1.15	1.05–1.24	1963-2001
Melanoma	111	101	1.10	0.90–1.31	103	1.08	0.88–1.28	1963-2001
Mesothelioma	17	15	1.15	0.66–1.81	15	1.12	0.64–1.76	1997-2001
Multiple myeloma	24	29	0.86	0.52–1.20	29	0.83	0.50–1.16	1968-2001
Nasal	3	4	0.75	0.15–2.17	4	0.74	0.15–2.12	1964-2001
NHL	70	90	0.78	0.60–0.96	93	0.76	0.58–0.94	1963-2001
Oesophagus	67	63	1.06	0.81–1.32	65	1.04	0.79–1.28	1963-2001
Oral cavity, pharynx and larynx	129	96	1.34	1.11–1.57	99	1.31	1.08–1.53	1968-2001
Head and neck	101	70	1.44	1.16–1.73	71	1.41	1.13–1.68	1968-2001
Larynx	28	26	1.09	0.69–1.49	27	1.06	0.67–1.46	1963-2001
Pancreas	101	83	1.21	0.97–1.45	86	1.18	0.95–1.41	1963-2001
Thyroid	2	4	0.51	0.06–1.78	4	0.50	0.06–1.74	1963-2001
Unknown primary	120	103	1.17	0.96–1.38	106	1.14	0.94–1.34	1968-2001

Table D6: Navy Vietnam veterans: Observed and expected number of cancer deaths, and standardised mortality ratios (SMRs).

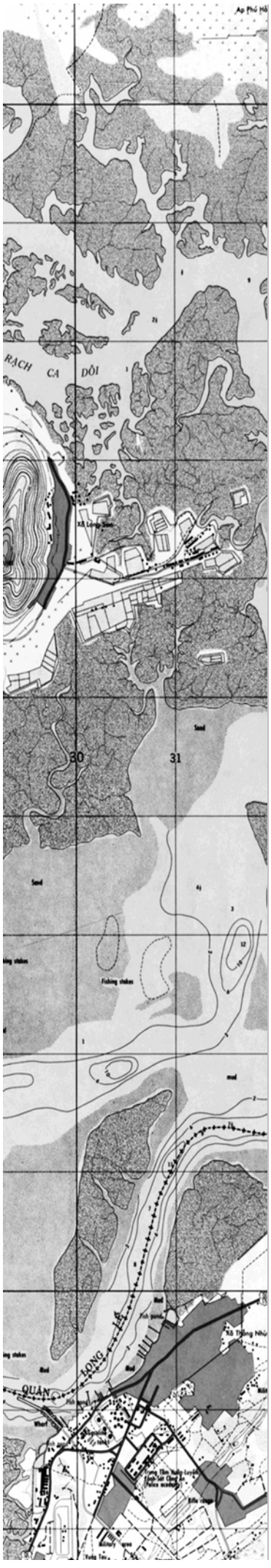
		Scenario 1 (excluding veterans whose status is unknown)			Scenario 2 (including veterans whose status is unknown)			
Cause of death	**Observed**	**Expected**	**SMR**	**95% CI**	**Expected**	**SMR**	**95% CI**	**Period**
All neoplasms	491	413	1.19	1.08–1.29	426	1.15	1.05–1.25	1963-2001
Brain and CNS	23	23	1.02	0.60–1.43	24	0.99	0.59–1.39	1963-2001
Breast	1	0	2.45	0.06–13.49	0	2.37	0.06–13.07	1963-2001
Connective soft tissue	3	4	0.85	0.17–2.43	4	0.83	0.17–2.37	1968-2001
Eye	1	0	2.16	0.05–11.92	0	2.10	0.05–11.56	1963-2001
Gastrointestinal	86	73	1.18	0.93–1.43	75	1.14	0.90–1.39	1968-2001
Colorectal	63	55	1.15	0.86–1.43	56	1.11	0.84–1.39	1963-2001
Colon	49	38	1.27	0.91–1.62	40	1.23	0.88–1.57	1963-2001
Rectum	13	16	0.82	0.43–1.38	17	0.79	0.42–1.34	1963-2001
Stomach	22	17	1.29	0.75–1.82	18	1.25	0.73–1.77	1963-2001
Genitourinary	43	39	1.10	0.77–1.43	40	1.06	0.74–1.37	1968-2001
Bladder	4	6	0.63	0.17–1.58	7	0.61	0.16–1.52	1963-2001
Kidney	12	11	1.09	0.55–1.87	12	1.05	0.54–1.81	1963-2001
Prostate	22	17	1.29	0.75–1.82	18	1.23	0.72–1.74	1963-2001
Testis	3	4	0.83	0.17–2.35	4	0.81	0.16–2.29	1963-2001
Hodgkin's disease	2	3	0.58	0.07–2.07	4	0.57	0.07–2.02	1963-2001
Leukaemia	22	17	1.29	0.75–1.82	18	1.25	0.73–1.77	1963-2001
Lymphoid leukaemia	1	4	0.22	0.01–1.24	5	0.22	0.01–1.20	1968-2001
Myeloid leukaemia	18	11	1.60	0.93–2.49	12	1.55	0.91–2.41	1968-2001
Liver and gallbladder	11	12	0.96	0.47–1.68	12	0.93	0.45–1.63	1963-2001
Lung	135	97	1.39	1.15–1.62	100	1.34	1.12–1.57	1963-2001
Melanoma	35	22	1.56	1.04–2.08	23	1.52	1.01–2.02	1963-2001
Mesothelioma	8	3	2.53	1.11–4.94	3	2.45	1.07–4.77	1997-2001
Multiple myeloma	3	6	0.50	0.10–1.46	6	0.49	0.10–1.41	1968-2001
Nasal	1	1	1.15	0.03–6.35	1	1.12	0.03–6.17	1964-2001
NHL	10	20	0.52	0.25–0.94	20	0.50	0.24–0.91	1963-2001
Oesophagus	13	13	0.99	0.52–1.67	14	0.96	0.50–1.62	1963-2001
Oral cavity, pharynx and larynx	28	21	1.38	0.87–1.89	21	1.34	0.85–1.83	1968-2001
Head and neck	22	15	1.49	0.87–2.10	15	1.44	0.84–2.04	1968-2001
Larynx	6	5	1.11	0.40–2.38	6	1.08	0.39–2.31	1963-2001
Pancreas	18	18	1.03	0.60–1.60	18	1.00	0.58–1.55	1963-2001
Thyroid	1	1	1.18	0.03–6.50	1	1.14	0.03–6.31	1963-2001
Unknown primary	24	22	1.12	0.67–1.56	22	1.08	0.65–1.51	1968-2001

Table D7: Army Vietnam veterans: Observed and expected number of cancer deaths, and standardised mortality ratios (SMRs).

		Scenario 1 (excluding veterans whose status is unknown)			Scenario 2 (including veterans whose status is unknown)			
Cause of death	**Observed**	**Expected**	**SMR**	**95% CI**	**Expected**	**SMR**	**95% CI**	**Period**
All neoplasms	1,323	1,281	1.03	0.98–1.09	1,311	1.01	0.95–1.06	1963-2001
Brain and CNS	66	71	0.93	0.71–1.16	73	0.91	0.69–1.13	1963-2001
Breast	3	1	2.49	0.51–7.18	1	2.44	0.49–7.01	1963-2001
Connective soft tissue	9	11	0.82	0.37–1.52	11	0.80	0.36–1.49	1968-2001
Eye	5	1	3.43	1.09–7.85	2	3.36	1.07–7.68	1963-2001
Gastrointestinal	206	226	0.91	0.79–1.03	231	0.89	0.77–1.01	1968-2001
Colorectal	152	169	0.90	0.75–1.04	173	0.88	0.74–1.02	1963-2001
Colon	107	119	0.90	0.73–1.07	121	0.88	0.71–1.05	1963-2001
Rectum	44	50	0.88	0.62–1.14	51	0.86	0.60–1.11	1963-2001
Stomach	50	54	0.93	0.67–1.19	55	0.91	0.66–1.16	1963-2001
Genitourinary	122	123	0.99	0.82–1.17	126	0.97	0.80–1.14	1968-2001
Bladder	13	20	0.65	0.34–1.09	21	0.63	0.33–1.06	1963-2001
Kidney	33	35	0.93	0.61–1.25	36	0.91	0.60–1.22	1963-2001
Prostate	65	56	1.17	0.89–1.46	57	1.14	0.86–1.41	1963-2001
Testis	10	11	0.92	0.43–1.65	11	0.91	0.42–1.63	1963-2001
Hodgkin's disease	11	10	1.11	0.54–1.94	10	1.09	0.53–1.91	1963-2001
Leukaemia	48	53	0.91	0.65–1.17	54	0.89	0.64–1.14	1963-2001
Lymphoid leukaemia	17	14	1.27	0.72–1.99	14	1.24	0.71–1.95	1968-2001
Myeloid leukaemia	30	36	0.83	0.53–1.13	37	0.81	0.52–1.10	1968-2001
Liver and gallbladder	33	36	0.91	0.60–1.22	37	0.89	0.58–1.19	1963-2001
Lung	339	301	1.13	1.01–1.25	308	1.10	0.98–1.22	1963-2001
Melanoma	66	69	0.96	0.73–1.20	70	0.94	0.72–1.17	1963-2001
Mesothelioma	9	10	0.91	0.41–1.70	10	0.89	0.40–1.65	1997-2001
Multiple myeloma	15	19	0.81	0.44–1.31	19	0.79	0.43–1.28	1968-2001
Nasal	2	3	0.76	0.09–2.71	3	0.75	0.09–2.65	1964-2001
NHL	52	61	0.85	0.62–1.08	62	0.83	0.61–1.06	1963-2001
Oesophagus	42	42	1.00	0.69–1.30	43	0.97	0.68–1.27	1963-2001
Oral cavity, pharynx and larynx	88	64	1.39	1.10–1.68	65	1.36	1.07–1.64	1968-2001
Head and neck	69	46	1.49	1.14–1.84	47	1.46	1.12–1.80	1968-2001
Larynx	19	17	1.13	0.67–1.74	17	1.11	0.65–1.70	1963-2001
Pancreas	71	55	1.30	1.00–1.60	56	1.27	0.97–1.56	1963-2001
Thyroid	1	3	0.38	0.01–2.04	3	0.37	0.01–2.00	1963-2001
Unknown primary	83	68	1.23	0.97–1.50	69	1.20	0.94–1.46	1968-2001

Table D8: Air Force Vietnam veterans: Observed and expected number of cancer deaths, and standardised mortality ratios (SMRs).

		Scenario 1 (excluding veterans whose status is unknown)			Scenario 2 (including veterans whose status is unknown)			
Cause of death	**Observed**	**Expected**	**SMR**	**95% CI**	**Expected**	**SMR**	**95% CI**	**Period**
All neoplasms	245	244	1.00	0.88–1.13	251	0.97	0.85–1.10	1963-2001
Brain and CNS	9	11	0.87	0.39–1.61	11	0.85	0.38–1.57	1963-2001
Breast	0	0	0.00	0.00–14.55	0	0.00	0.00–14.13	1963-2001
Connective soft tissue	0	2	0.00	0.00–2.29	2	0.00	0.00–2.24	1968-2001
Eye	0	0	0.00	0.00–15.00	0	0.00	0.00–14.63	1963-2001
Gastrointestinal	38	44	0.86	0.59–1.14	45	0.84	0.57–1.10	1968-2001
Colorectal	34	33	1.02	0.67–1.36	34	0.99	0.66–1.33	1963-2001
Colon	21	23	0.92	0.53–1.31	24	0.89	0.51–1.27	1963-2001
Rectum	12	10	1.27	0.64–2.16	10	1.23	0.62–2.10	1963-2001
Stomach	4	10	0.41	0.10–0.98	11	0.40	0.10–0.95	1963-2001
Genitourinary	32	26	1.20	0.78–1.62	27	1.16	0.76–1.57	1968-2001
Bladder	5	5	1.11	0.35–2.54	5	1.08	0.34–2.46	1963-2001
Kidney	5	6	0.80	0.25–1.83	7	0.78	0.25–1.78	1963-2001
Prostate	19	14	1.38	0.81–2.10	15	1.32	0.78–2.02	1963-2001
Testis	0	1	0.00	0.00–3.30	1	0.00	0.00–3.25	1963-2001
Hodgkin's disease	0	1	0.00	0.00–2.86	1	0.00	0.00–2.81	1963-2001
Leukaemia	14	8	1.62	0.82–2.62	9	1.58	0.79–2.55	1963-2001
Lymphoid leukaemia	6	2	2.71	0.97–5.76	2	2.64	0.95–5.61	1968-2001
Myeloid leukaemia	8	6	1.34	0.50–2.55	6	1.31	0.48–2.48	1968-2001
Liver and gallbladder	4	7	0.64	0.16–1.51	7	0.62	0.16–1.47	1963-2001
Lung	71	64	1.11	0.85–1.37	66	1.08	0.83–1.33	1963-2001
Melanoma	10	10	1.01	0.47–1.82	10	0.99	0.46–1.78	1963-2001
Mesothelioma	0	2	0.00	0.00–2.06	2	0.00	0.00–2.00	1997-2001
Multiple myeloma	6	4	1.70	0.61–3.61	4	1.65	0.59–3.50	1968-2001
Nasal	0	0	0.00	0.00–7.41	1	0.00	0.00–7.24	1964-2001
NHL	8	10	0.86	0.36–1.61	10	0.84	0.35–1.57	1963-2001
Oesophagus	12	8	1.54	0.78–2.63	8	1.50	0.76–2.55	1963-2001
Oral cavity, pharynx and larynx	12	12	1.02	0.52–1.75	12	1.00	0.50–1.70	1968-2001
Head and neck	9	8	1.09	0.49–2.03	9	1.07	0.48–1.98	1968-2001
Larynx	3	4	0.87	0.18–2.48	4	0.85	0.17–2.41	1963-2001
Pancreas	11	11	1.07	0.51–1.83	11	1.04	0.50–1.78	1963-2001
Thyroid	0	0	0.00	0.00–7.84	0	0.00	0.00–7.64	1963-2001
Unknown primary	12	13	0.93	0.47–1.58	14	0.90	0.46–1.54	1968-2001



Accuracy of National Death Index Matching

Appendix E Accuracy of National Death Index Matching

E.1. Introduction

The National Death Index (NDI) played a vital role for confirming deaths for those veterans listed as deceased on the Veterans' Affairs Client Data Base and for finding new deaths which Veterans' Affairs did not previously know about. A previous mortality study of Australian Vietnam veterans[1] determined that the NDI matching was not finding all deaths, reporting sensitivity rates of 62.2% and 89.2% for the 'without date of death' and 'with date of death' matching. Study results were adjusted to compensate for this under-ascertainment of deaths.

The test described below examines whether the use of better matching algorithms and more complete databases employed in the current study justifies the decision not to adjust the findings of this study's matching results.

E.2. Method

To measure the effectiveness of the matching process, 541 veterans known to be alive and 434 veterans known to be dead were randomly selected from the study cohort. The deaths were known to DVA and occurred in 1980 or later and should therefore be on the NDI unless they died overseas.

The cohort was matched with the NDI twice. First, the date of death was used as a field for matching. This tested the ability of the NDI to detect known deaths. Second, the date of death was not used for matching. This tested the ability of the NDI to detect deaths not listed on the Veterans' Affairs Client Data Base.

E.3. Results

Table E1: Sensitivity and specificity of the NDI matching of Vietnam veterans with date of death

	True status		
NDI match	**Dead**	**Alive**	**Total**
Yes	432	0	432
No	2	541	543
Total	434	541	975
Sensitivity = 432/434 = 99.5%			
Specificity = 541/541 = 100%			

Table E2: Sensitivity and specificity of the NDI matching of Vietnam veterans without date of death

	True status		
NDI match	**Dead**	**Alive**	**Total**
Yes	420	0	420
No	14	541	555
Total	434	541	975
Sensitivity = 420/434 = 96.8%			
Specificity = 541/541 = 100%			

E.4. Discussion

Tables E1 and E2 show that the sensitivity of matching with the NDI varies according to the presence or absence of a date of death. However, both tests have a very high sensitivity and specificity.

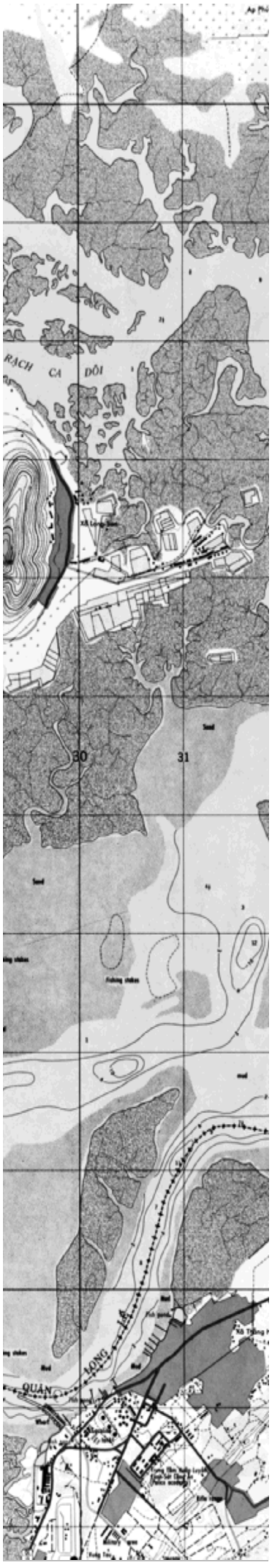
It was not possible to replicate exactly the 1997 Mortality of Vietnam veterans' test of NDI matching, and the results of the tests cannot therefore be compared directly. The quality of the NDI has improved over the years, and the 1997 study had a greater percentage of poor NDI data compared to the present study. Adjusting the above test to only 1980 to 1994 deaths lowered the sensitivity to 87.5% when not using the date of death, and raised the sensitivity to 100% when using the date of death.

The test results cannot be used to quantify the degree of under-ascertainment in the study proper because the test cohort was based on veterans known to DVA as having died, which may have introduced a bias. Furthermore, death information was sourced from multiple sources and date of death information, if available, was always used.

The test results have, however, reassured the study team that the NDI matching had a high sensitivity and specificity, and that under-ascertainment of deaths was not a major issue in the current study although it may have been an issue in the 1997 report.

E.5. References

1 Crane P, Barnard D, Horsley K, Adena M. Mortality of Vietnam veterans: The veteran cohort study: A report of the 1996 retrospective cohort study of Australian Vietnam veterans. Canberra: Department of Veterans' Affairs, 1997.



Consultative Forum

Appendix F Consultative Forum

F.1. Chair

Major General Paul Stevens AO (Rtd)
Repatriation Commissioner to 24 August 2003

Rear Admiral Simon Harrington AM (Rtd)
Repatriation Commissioner from 25 August 2003

F.2. Membership

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Mr Tim McCombe OAM
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Mr John King
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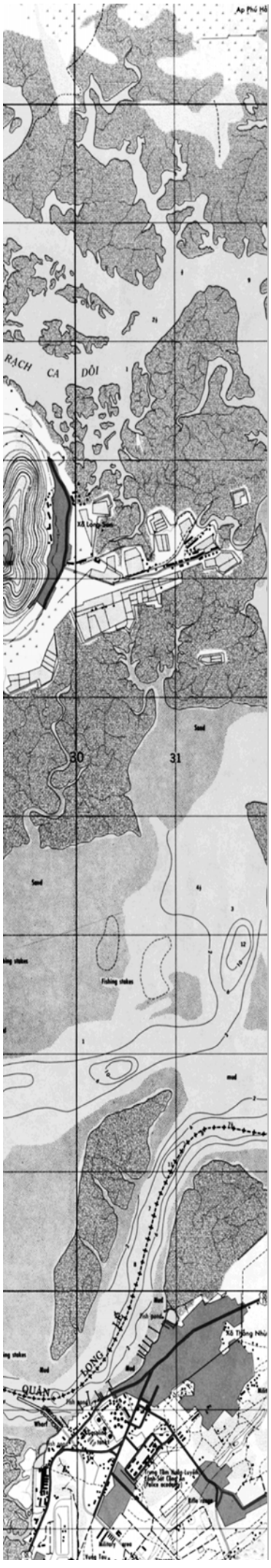
Rear Admiral Guy Griffiths AO DSO DSC
Australian Veterans and Defence Services Council to November 2003

Mr Colin Doust
Australian Veterans and Defence Services Council from March 2004

Commodore Michael Dowsett AM (Rtd)
Naval Association of Australia



Scientific Advisory Committee

Appendix G Scientific Advisory Committee

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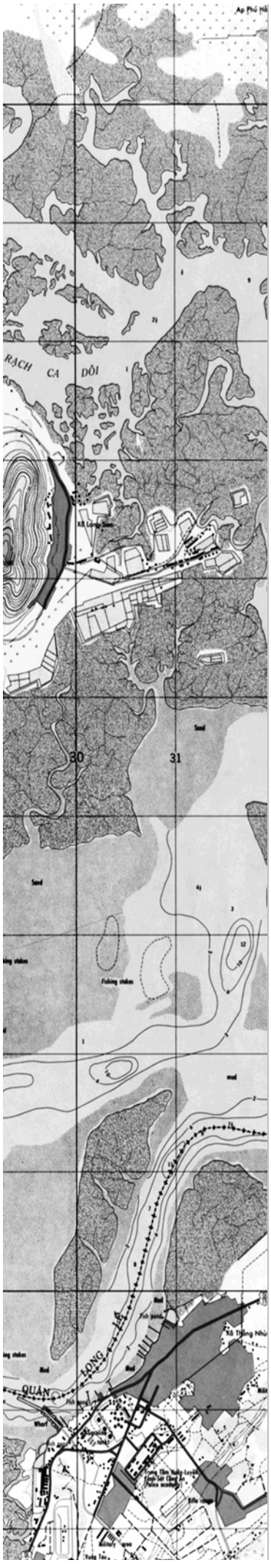

Project Team

Appendix H Project Team

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