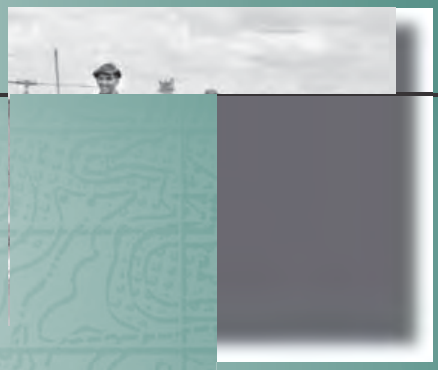
Australian Government
Department of Veterans' Affairs
Australian Institue of
Health and Welfare

Cancer Incidence

in Australian Vietnam Veterans

Study 2005



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Australian Government
The Repatriation Commission

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The Hon De-Anne Kelly, MP
Minister for Veterans' Affairs
Parliament House
CANBERRA ACT 2600

Dear Minister

I have pleasure in submitting to you the final report of the *Cancer Incidence in Vietnam Veterans Study 2005*. The Repatriation Commission considered this report at its meeting of 5 May 2005 and noted its findings. This study has investigated the cancer incidence for male military Vietnam veterans from 1982 to 31 December 2000. It is the first time cancer incidence has been studied for all three Service branches.

This report is the first of four volumes to be published in this series on Vietnam veterans. The second volume will be a mortality 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. These reports will be finalised during the year.

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 D of the Cancer Incidence 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 E of the report.

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

Yours sincerely

Simon Harrington
COMMISSIONER

1 June 2005

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22 February 2005

Rear Admiral Simon Harrington AM
Repatriation Commissioner
Department of Veterans' Affairs
Lovett Tower
13 Keltie Street
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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 first volume of the current series of studies – *Cancer Incidence in Australian Vietnam Veterans 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.

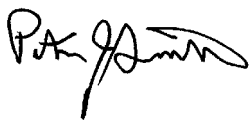
As the report notes, the study has found that there is an increased incidence of cancer overall. However, the pattern of increase is complex and it does not appear that there is any simple explanation for the observed findings.

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
AVH	Australian Veteran Health Study
CARO	Central Army Records Office
DIMIA	Department of Immigration, Migration and Indigenous Affairs
DVA	Australian Government Department of Veterans' Affairs
HIC	Health Insurance Commission
ICD-10	International Classification of Diseases – Revision 10
NAA	National Archives of Australia
NAS	National Academy of Science
NCSCH	National Cancer Statistics Clearing House
NDI	National Death Index
NRVV	Nominal Roll of Vietnam Veterans
NYSIIS	New York State Intelligence Information System
SEATO	South-East Asian Treaty Organisation
SD	Standard deviation
SIR	Standardised Incidence Rate
RBDM	State and Territory Registrars of Births, Deaths and Marriages
RN	Royal Navy (British)
RNZN	Royal New Zealand Navy
VEA	*Veterans' Entitlements Act 1986*

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.

Establishing the 1st Australian Logistic Support Group in the sand dunes at Vung Tau, 1966. *[AWM MISC/66/0020/VN]*

Mortar fire by 2 RAR in support of a reconnaisance-in-force operation, 1968. *[AWM CAM/68/0184/VN]*

Meals served outdoors to 1RAR, 1965. *[AWM DNE/65/0047/VN]*

Navy divers from CDT3 operating in the port of Vung Tau. *[AWM NAVY M0617/6]*

Mortar fire by 2 RAR in support of a reconnaisance-in-force operation, 1968. *[AWM MISC/69/0277/VN]*

Unloading HMAS *Sydney* at Vung Tau, 1967. *[AWM SKE/67/1280/VN]*

Landing craft preparing to move soldiers of 6RAR from HMAS *Sydney* to Vung Tau, 1969. *[AWM BEL/69/0327/VN]*

A Centurion tank bogged in the tropical conditions, 1969. *[AWM P01381.009]*

9 Squadron Door Gunner supporting infantry operations, 1969. *[AWM P00788.006]*

Transferring empty shell cases from HMAS *Hobart* to a supply ship. *[AWM M0628/25]*

Resupply at Fire Support Base Coral, 1968. *[AWM CRO/68/0553/VN]*

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 first of four volumes to be published and is the first investigation of cancer incidence for male Australian Vietnam veterans from all three branches of the armed forces – Navy, Army and Air Force. The number of females who served in Vietnam were too few for meaningful results in a study of this kind.

Study objectives

The objectives of the cancer incidence study were to:

- identify cases of cancer (excluding non-melanocytic skin cancers) among Vietnam veterans during the period 1982 to 2000 inclusive;
- compare the number of cases of cancer among Vietnam veterans with the number of expected cancers based on cancer incidence of the Australian community;
- report any differences in the cancer incidence for specific types of cancer, as highlighted by past studies and the literature review, from the Australian community;
- investigate any differences in cancer incidence between Navy, Army and Air Force Vietnam veterans;
- investigate any relationship between cancer incidence and exposure of Navy veterans to Vietnamese waters; and
- establish lists of personnel who served onboard HMA ships and Army small ships deployed to Vietnam and determine cancer incidence on a ship-by-ship basis.

Study design

The cancer incidence study is a retrospective cohort study of male Australian personnel who served in Vietnam between 23 May 1962 and 1 July 1973. The study examines cancers diagnosed during the period from 1982 to 31 December 2000. The study compares the cancer incidence rates of male Australian Vietnam veterans with those of Australian males in the general community. All comparisons have been standardised by age and year of diagnosis. In addition, the study analyses whether cancer incidence rates vary between different groups of Vietnam veterans or by duration of service in Vietnamese waters.

Report structure

Chapter One provides a background to previous studies and an overview of the study. **Chapter Two** of this Report provides a brief summary of the Vietnam War and Australia's involvement, which was formally announced in May 1962. There was a gradual build up of numbers, peaking in 1968, followed by a gradual decline until most of the troops had departed by the end of 1972.

The roll compiled for this study was drawn from the Nominal Roll of Vietnam Veterans currently maintained by DVA, as described in **Chapter Three**. The Nominal Roll has been extensively updated since it was last published in 1997. 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 Vietnam veterans.

The methodology for this study is 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 cancers. Vital status was determined for 97.5% of the cohort and 2.5% were lost to follow up. The number of cancers 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. The Navy personnel were substantially younger than the Army or Air Force personnel when they first served in Vietnam.

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

Findings

The results presented in **Chapter Six** show that Australian Vietnam veterans have a significantly elevated overall cancer incidence rate that is 13-15% higher than expected.

Incidence rates for specific cancers of *a priori* interest showed a mixed pattern. Rates of five cancers (head and neck, lung, prostate, Hodgkin's disease and melanoma) were significantly higher than expected. Four cancers (liver, thyroid, multiple myeloma and non-Hodgkin's lymphoma) showed a significantly lower cancer rate than expected.

The pattern of cancer incidence varied between the Service branches. Navy veterans had the highest rate of cancer, higher than expected by 22-26%, followed by Army veterans, higher than expected by 11-13%. In comparison Air Force veterans had a 6-8% higher than the expected rate of cancer, although this was not statistically significant.

Veterans from all Service branches showed a higher than expected incidence of genitourinary cancers and melanoma. Navy and Army veterans showed a higher than the expected incidence of cancers of the lung, oral cavity, pharynx and larynx and cancers of the head and neck. Whereas Navy veterans demonstrated a higher than the expected incidence of gastrointestinal cancer, Army and Air Force veterans showed higher than the expected incidence of Hodgkin's disease and prostate cancer. It should be noted that veterans from all three Service branches showed lower than the expected incidence of non-Hodgkin's lymphoma.

An exposure of particular interest to Vietnam veterans is the herbicides that were used in Vietnam. The rate for several of the cancers that have been associated with herbicide exposure are high in this study; several others do not differ from expectation; others are significantly below the community norm.

Within the limitations of the service details available for Navy personnel, the higher than expected cancer incidence among this group could not be attributed to either the ship on which they served or the time spent in Vietnamese waters.

Strengths and Weaknesses of the Study

As discussed in **Chapter Seven**, the strengths of the study include its size, data quality, high percentage of known vital status, homogeneity of the study population, extensive consultation with the veteran community and close external scientific advice.

The study had limited ability to quantify exposures, making it difficult to assign any observed outcome to a particular exposure. A discussion of the possible exposures that could be an explanation of the observed pattern of cancer is contained within this Report, but, given the uncertainties associated with exposure, this discussion is, by necessity, speculative in nature.

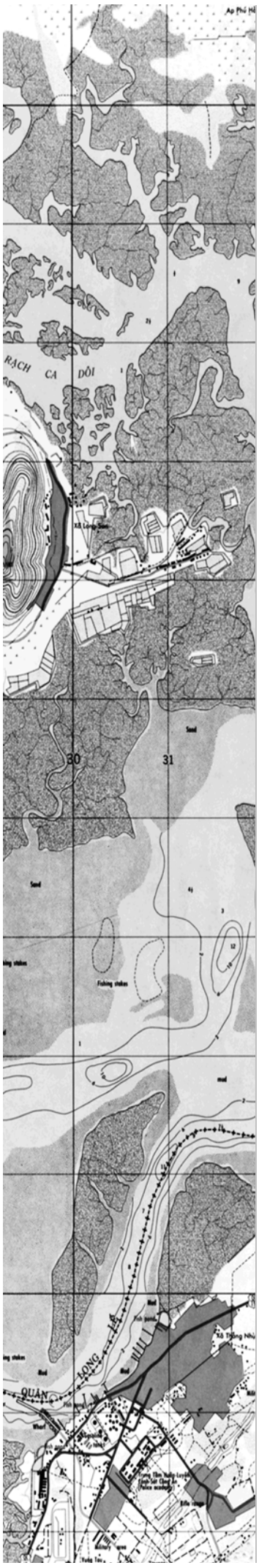
Conclusion

In conclusion, this study provides good evidence that Australian male veterans of the Vietnam War have an increased rate of cancer overall. There was an excess of 613 cancers; 88% of this excess consisted of lung cancers, oral cavity, pharynx and larynx cancers, prostate cancers and melanomas. The pattern is not generally consistent across the Navy, Army and Air Force veterans, although melanoma, and to a lesser degree prostate cancer, were consistently elevated in all three groups.

Additional Work

Three more reports will be completed in this series during 2005. The second volume will be a mortality study of all male 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 male Army cohort.

This further research may enable more useful observations to be made about the health of Vietnam veterans.



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 first of four volumes to be published and is the first investigation of cancer incidence for male Australian Vietnam veterans from all three branches of the armed forces. The second volume will be a mortality 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, are 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 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] Further details on the sources used and estimations of the completeness of the original roll are given in Chapter 3.

A Nominal Roll of Vietnam Veterans was published in both 1996 and 1997. The 1996 version was considered to be the most definitive record of Australian Vietnam veterans produced, to date. However, DVA acknowledged that, despite the best intentions of those who compiled the Nominal Roll, there would be errors or omissions. Contact details were provided for those veterans who wished to report these errors or omissions to the Department of Defence.[14] The edition of the Nominal Roll of Vietnam Veterans published in 1997 incorporated those notifications that had been verified by the Department of Defence as eligible for inclusion.[15] Requests for additions and amendments to the Nominal Roll continued after its 1997 publication.

Overall, there have been in excess of 800 errors or omissions identified by veterans, historians and ex-Service organisations that resulted in amendments to existing entries or the addition of new entries to the Nominal Roll. 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 4600 changes to the Nominal Roll and is outlined in Chapter 3.

1.3 Overview of the Cancer Incidence in Australian Vietnam Veterans Study

The study presented in this report represents the first time cancer incidence has been investigated among male Australian Vietnam veterans for all three military Service branches and extends the cancer incidence data of Army veterans by 11 years. Also, in light of the water distillation study,[13] the cancer incidence study investigates the effect of exposure to Vietnamese waters for those who served on Navy ships and Army small ships.

1.3.1 Objectives of the study

The objectives of the cancer incidence study are to:

- identify cases of cancer (excluding non-melanocytic skin cancers) among Vietnam veterans for the period 1982 through 2000;
- compare the number of cases of cancer among Vietnam veterans with the number of expected cancers based on cancer incidence of the Australian community;

- report any differences in the cancer incidence for specific types of cancer, as highlighted by past studies and the literature review, from the Australian community;
- investigate any differences in cancer incidence between Navy, Army and Air Force Vietnam veterans;
- investigate any association between cancer incidence and exposure of Navy veterans to Vietnamese waters; and
- establish lists of personnel who served onboard HMA ships and Army small ships deployed to Vietnam and determine cancer incidence on a ship-by-ship basis.

1.3.2 Study design

The cancer incidence 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 cancer incidence rates for the period from 1982 to 31 December 2000. The study compares the cancer incidence rates of male Australian veterans with those of Australian males. All comparisons have been standardised by age and calendar year of cancer diagnosis. In addition, the study analyses whether cancer incidence rates vary between different groups of Vietnam veterans or by duration of time served in Vietnamese waters.

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 D), while a Scientific Advisory Committee (Appendix E) was established to oversight the scientific aspects of the study. The study was conducted by DVA in conjunction with AIHW (Appendix F).

A protocol for this study was completed in 2002 (Appendix A). 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. The study protocol was also successfully submitted to each of the State cancer registries.

1.3.4 Definition of the veteran cohort

This report describes the cancer incidence 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 the ship-by-ship analysis, this data was supplemented with period of time in Vietnamese waters for Navy personnel. This data was drawn from relevant ships' logs and published histories.

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

- vital status;
- date of death; or
- last known date alive;
- diagnosis of cancer: 4 digit ICD-10 codes for cancer type; and
- date of diagnosis.

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

1.3.6 Specific cancers

Overall cancer incidence, in addition to specific cancers, were investigated where it was considered that Vietnam veterans might differ from Australian males.

The specific cancers (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: Cancers of *a priori* interest

Cancer	ICD-10 chapter/codes	Source
Cancers	C00-C97, ex C44	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
Leukemia	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

Numbers of specific cancers were determined by AIHW through matching with the National Cancer Statistics Clearing House (NCSCH). These diagnoses of cancer were coded using the International Classification of Diseases, Revision 10 (ICD-10) (see Table 1-1). These were compared with cancer incidence 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 cancer incidence rates of male Vietnam veterans are presented in Chapter 6. Chapter 7 reviews the cancer incidence findings, summarises the study and formulates conclusions.

The study protocol is reproduced in Appendix A. The literature review for the study is at Appendix B. Appendix C provides cancer incidence tables. Members of the study's Consultative Forum, the Scientific Advisory Committee and the project staff are listed in Appendices D, E and F respectively.

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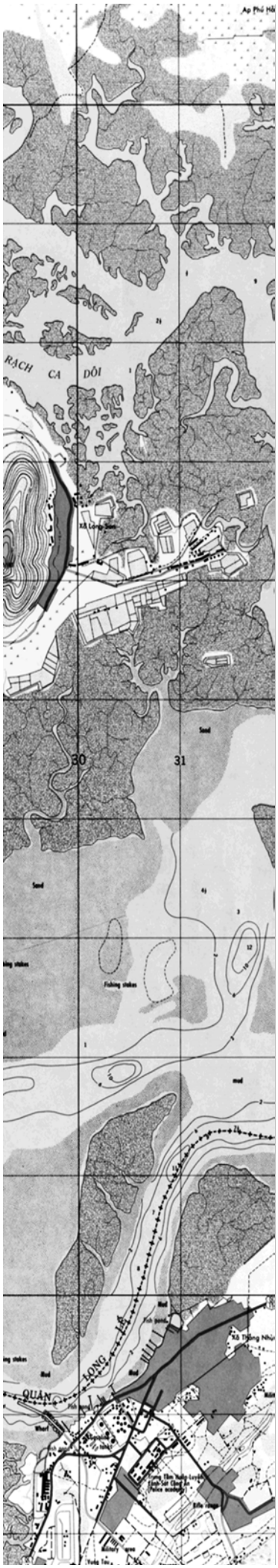


2

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. 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 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 better 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 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 3 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 *Veterans' Entitlements Act 1986* 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 began the Australian Army's commitment to the Vietnam War. The Royal Australian Navy 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 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 Australian Army Training Team Vietnam 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

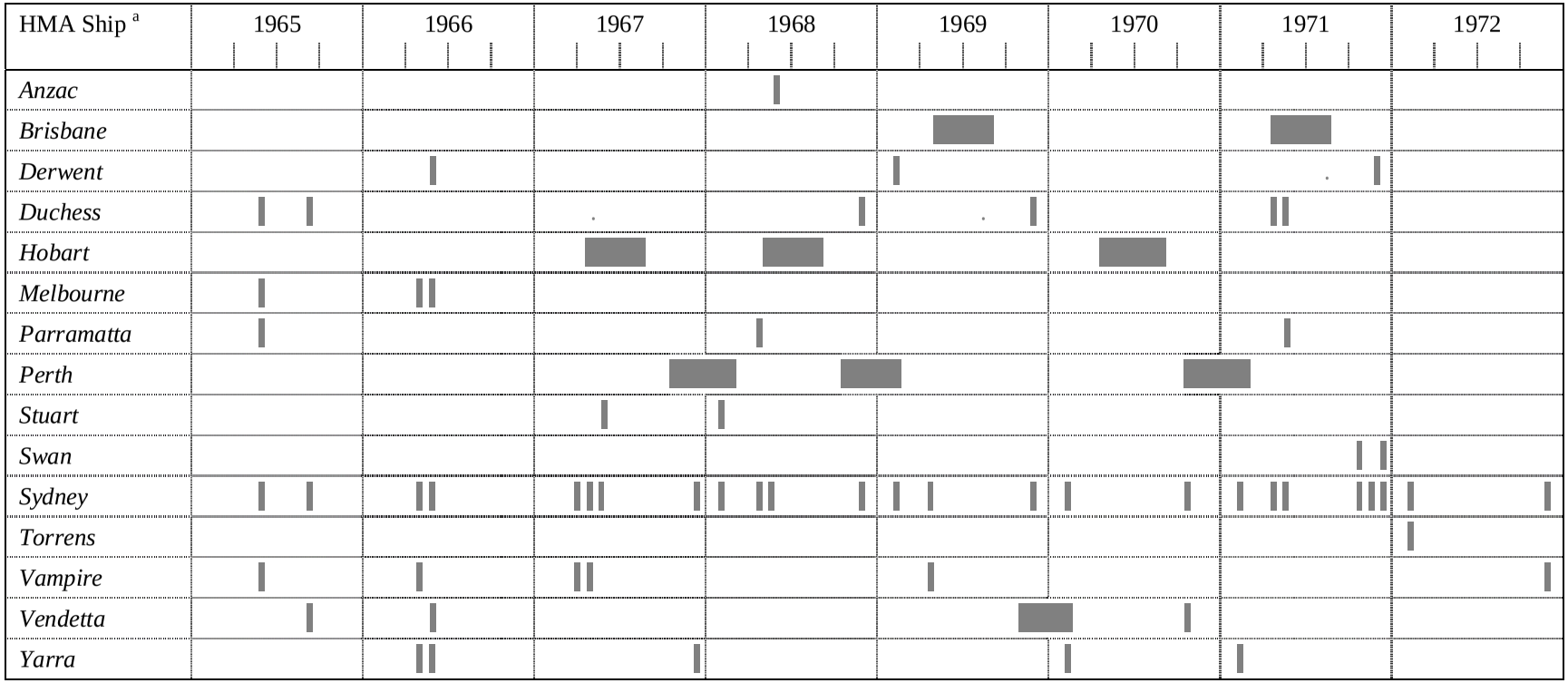
For many Australians, their perception of the Vietnam War has been informed through American culture and is influenced by some Australian commemorative practices that centre the Vietnam experience on particular sites and events along similar lines to earlier wars.[6] In this section, aspects of Australian 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 2-2 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 South-East Asian Treaty Organisation where HMA Ships were required to maintain a high operational readiness.[10]



[a] Excluding the cargo vessels *Boonaroo* and *Jeparit*.

Note: 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 2-2: 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*.

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. 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).[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. Figure 2-4 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.[13] 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.[14]

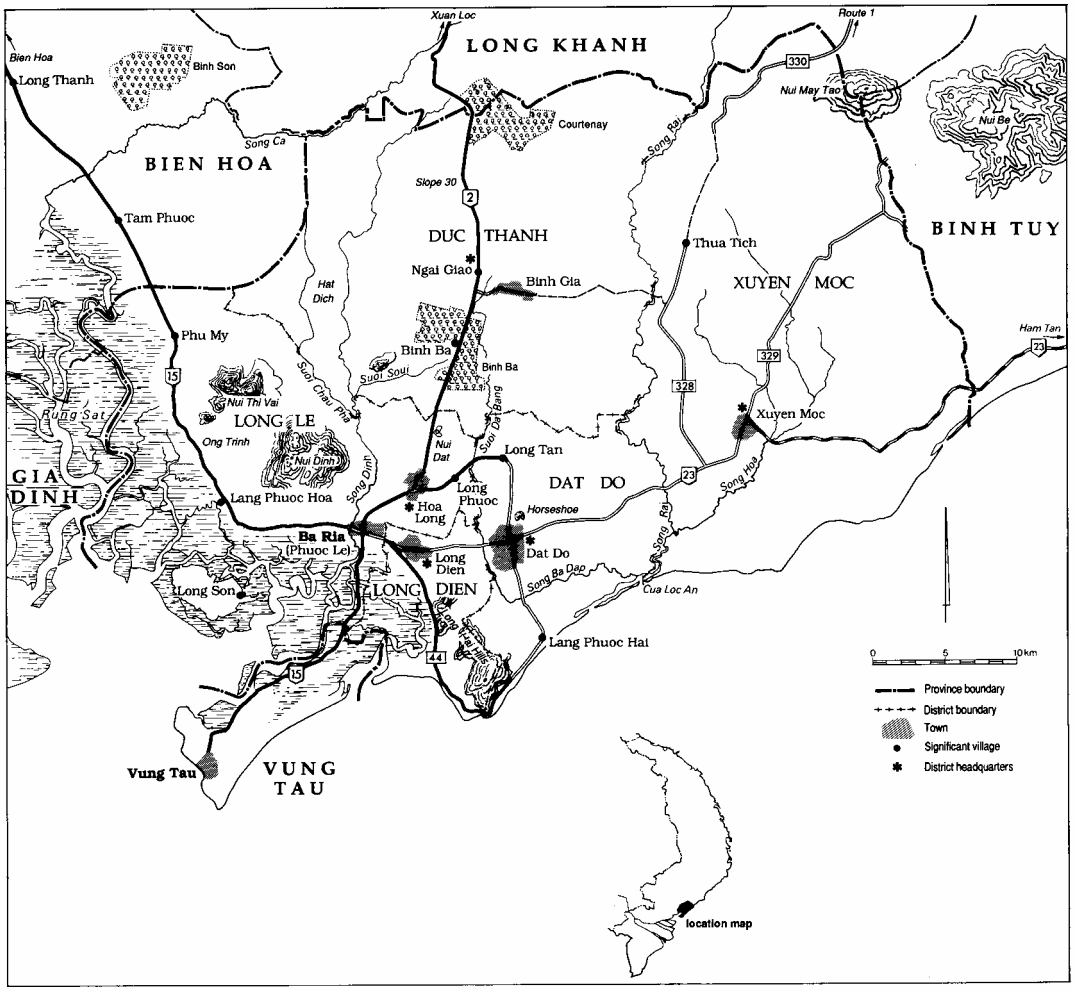


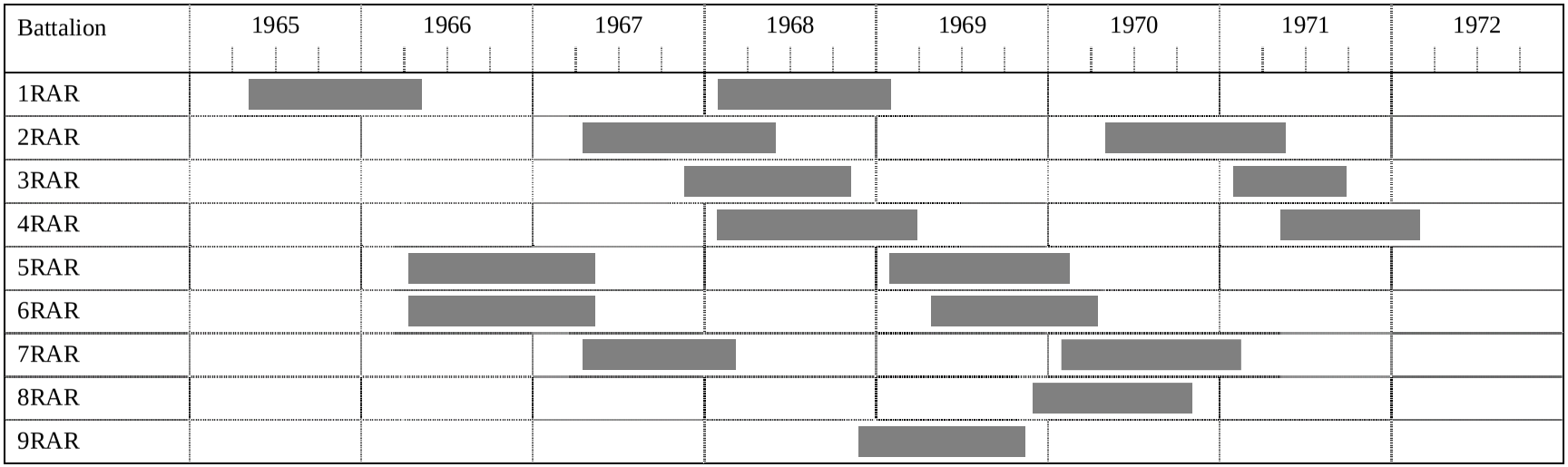
Figure 2-3: Phuoc Tuy Province

(Reproduced with permission of Australian War Memorial)

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.[15]

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.[16]



Note: 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 2-4: Periods the Battalions of the Royal Australian Regiment were allotted for duty during Vietnam War.

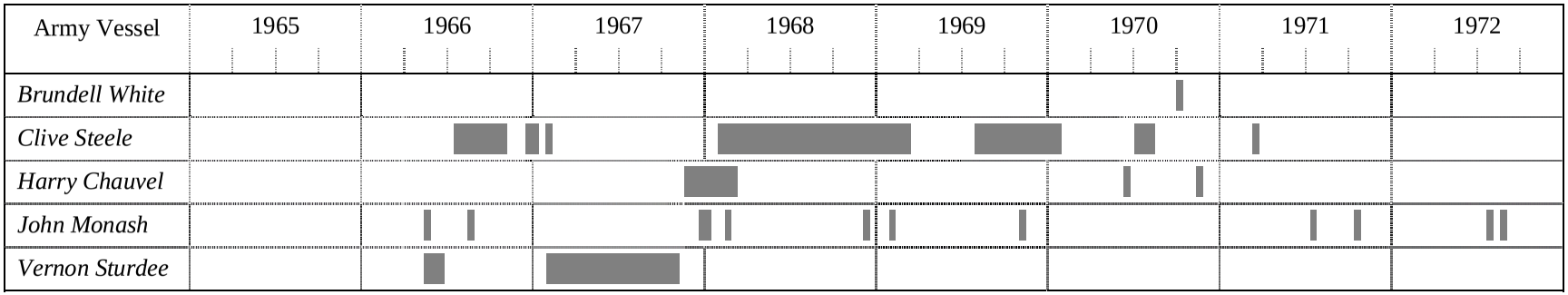
Another feature of the changing nature of military service was the increased reliance on a new style of air mobile warfare. This new style of warfare combined the use of helicopters with traditional artillery fire support. The primary Australian ground commitment was made up of Army combat units who spent 12 months in Vietnam before returning to Australia. Long periods were spent on operations, punctuated by short periods for rest and refit.[17] 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.[18]

The Australian Army involvement in the Vietnam War stretched from 1962 through to 1973. During this period, the way the war was conducted changed and, as a result, soldiers serving in the same unit could return to Australia with vastly different experiences. For example, the Australian Army Training Team Vietnam (AATTV) was initially isolated in training centres but by the close of 1964 had moved into an operational advising role in the field.[19] A change in leadership of the Australian Task Force in 1967 is reported to have resulted in a move away from the counter-insurgency practices of the cordon-and-search and a move towards the American practices of the search-and-destroy operation. A subsequent change in the American leadership resulted in a gradual shift back to operations of counter-insurgency.[20]

32 Small Ship Squadron

The protocol for this study (refer Appendix A) specifically mentions the Australian Army's 32 Small Ship Squadron. An unpublished thesis[21] obtained from a former member of the Squadron provides the following information about the experience of those who served in Vietnam onboard the five ships. The 32 Small Ship Squadron comprised four watercraft (Landing Ship Medium or LSM) named after prominent Australian generals – AV 1353 *Harry Chauvel*, AV 1354 *Brudenell White*, AV 1355 *Vernon Sturdee*, and AV 1356 *Clive Steele*. The Squadron also operated a cargo vessel, AS 3051 *John Monash*. Each of these ships saw service in the Vietnam War operational area, as well as transporting personnel and equipment from Australia to Vietnam. Their periods of service are illustrated in Figure 2-5.

The LSMs were initially deployed in 1966 to assist with the establishment of the Task Force. Thereafter, they were retained for unloading the cargo vessel *Jeparit*. However, from 1968 onwards, their role was expanded to overcome logistical and tactical problems associated with the deployment of Centurion tanks. Crew members were rotated on a six-monthly basis. The demand for LSM support was high, ferrying ammunition, tanks, vehicles and general stores for Australian and US forces. Coastal ports commonly serviced by the LSMs included Cam Ranh Bay, Vung Tau, Phan Thiet, Phan Rang, Nha Trang, Qui Nhon and Da Nang.



Note: Dates sourced from ship itineraries complied from individual Record of Service forms.

Figure 2-5: Periods in the Vietnam War operational area for vessels of Army's 32 Small Ship Squadron

Working and living conditions onboard were basic. The ships were not designed for working in the tropics. One of the main problems was the supply of fresh water. The ships were fitted with a vapour compressor for the desalination of seawater, but its operation raised the interior temperature of the engine room and fresh water was often sourced by other means.

Once into open water, these flat-bottomed vessels were increasingly uncomfortable. Rough weather resulted in a significant roll and, when combined with the pounding of the flat hull, crew members would be thrown out of their bunks.

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.[22]

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, as well as aerial spraying of defoliants.[23]

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.[24]

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 United States Air Force units.

The 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.[25]

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 Department of Veterans' Affairs to carry out government policy and implement programs to fulfil Australia's obligations to war veterans, members of the Australian Defence Force and their dependants. Within the parameters of this study, the 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 Royal Australian Navy 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.[26] 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.[27]

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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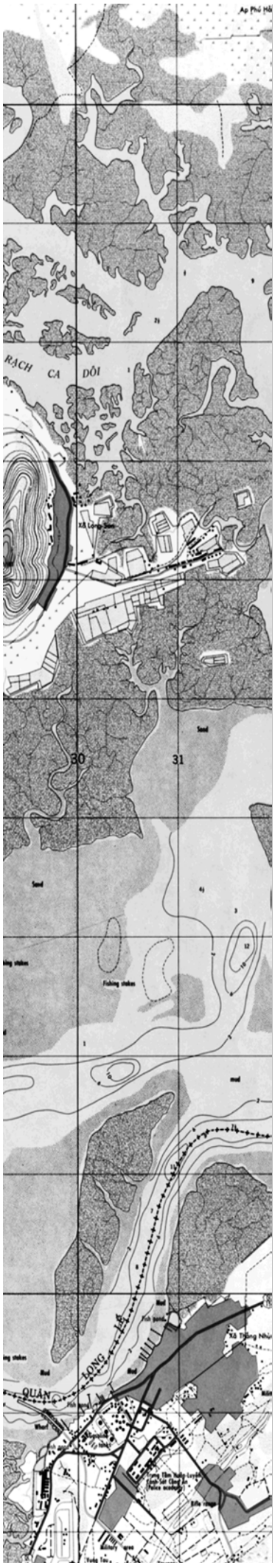


3

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 that is currently maintained by the Department of Veterans' Affairs. 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 Nominal Roll of Vietnam Veterans 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 Nominal Roll of Vietnam Veterans was originally sourced from the Department of Defence. The rolls of Navy and Army personnel were developed from lists supplied by the Navy Office and Army Office respectively. For the 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 the 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 Nominal Roll of Vietnam Veterans 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. 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 Nominal Roll of Vietnam Veterans, DVA requested all readers who identified errors or omissions in the roll to contact the relevant branch of the Department of Defence. The Department of Defence 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 Department of Defence.

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 enquiries from the veteran community directed to DVA. The Department of Defence 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 Nominal Roll of Vietnam Veterans.

Research conducted by DVA

DVA adopted two strategies for improving the completeness of the Nominal Roll of Vietnam Veterans 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. The 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]

This study aimed to include a ship-by-ship analysis of Navy personnel. Therefore, it was considered necessary to reduce the gap in the Navy records. Archival materials, in the form of Next of Kin Lists, were identified and a selection cross-checked with the Nominal Roll. The accuracy of crew complements on the Nominal Roll for voyages prior to 1970, when manual personnel systems were used, emerged as a concern. Of 335 Next of Kin List entries, spread over four voyages of HMAS *Sydney*, an average of 7.8% were missing from the Nominal Roll and a further 18.5% were on the roll but did not have a service entry corresponding to the voyage being checked. The percentage of errors was considered unacceptably high and could adversely impact results. In response, all available lists prior to 1970 for HMAS *Sydney* and the escort ships were cross-checked against the roll. Possible additions to the Nominal Roll were confirmed against personnel cards held at the National Archives of Australia (NAA).

There were three significant outcomes from this exercise. Firstly, 1,046 veterans were added to the Nominal Roll of Vietnam Veterans and consequently to the Study Roll. Secondly, 2,358 additional voyages to Vietnam for veterans already listed were added to both rolls. And thirdly, 14 people on the Nominal Roll were identified as being on loan or exchange from the Royal Navy (RN) or the Royal New Zealand Navy (RNZN) at the time they passed into the Vietnam War operational area. Their enlistment with the RN or RNZN made them ineligible for inclusion on the Nominal Roll of Vietnam Veterans. Therefore, their details were removed from both the Nominal Roll and the Study Roll. It is anticipated that this exercise has not identified all RN or RNZN personnel who served onboard HMAS *Sydney* and the escort ships, particularly after 1970. However, the likely number remaining is considered to be low enough to have minimal impact on the study results.

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 Department of Defence 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. These duplicates fell into three categories. Firstly, 25 sets were identified as containing incorrect duplications of existing names, that is the same person had been incorrectly entered twice. The incorrect listings were removed from both the Nominal Roll and the Study Roll. Secondly, the Department of Defence verified nine apparent duplicates as separate individuals. These veterans were retained on both the Nominal Roll and Study Roll. However, it was expected that such similarities would limit the ability of AIHW to undertake data matching for vital status and any cancer incidence and cause of death. Thirdly, 13 people were identified as having served in more than one branch of the armed forces in Vietnam. This category does not include, for example, Air Force personnel who served with an Army unit, or Navy personnel who served with an Air Force squadron. Instead, 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. In addition to the RN and RNZN entries and incorrect duplications mentioned above, Army and Navy personnel 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 Nominal Roll of Vietnam Veterans, 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 Nominal Roll of Vietnam Veterans 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 Nominal Roll of Vietnam Veterans 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.

3.2.2 Period in Vietnamese waters data

For this study, the Study Roll includes a set of variables relating to the period spent in Vietnamese waters. Two separate strategies were adopted to determine time spent in Vietnamese waters for those who served on ships. The first relates to Navy personnel serving on board HMA Ships. The second relates to Army personnel serving on board the vessels of 32 Small Ship Squadron.

Navy

The first step in the process of allocating Vietnamese water dates to each individual was to translate the posting dates recorded on the Nominal Roll into allocations to specific voyages to Vietnam. For the Navy entries, the original Nominal Roll displayed the dates for which an individual was posted to a particular ship. The name had been included on the original roll if the ship had been to Vietnam during that posting. In contrast, each voyage to Vietnam has a set of dates for which the ship's personnel are eligible for coverage under the *VEA*. These voyage dates correspond with the last port of call prior to entering the operational area and the first port of call after departing the operational area. The process of data translation had two outcomes. Firstly, service dates on the Nominal Roll were now aligned with Vietnam service. Secondly, multiple voyages to Vietnam during the one posting were now displayed as multiple service entries on the roll with service dates corresponding to coverage under the Act. For the purposes of this study, these are referred to as 'VEA Dates'.

The second step in the process was to identify when each ship entered and departed the operational area. Photocopies of ship logs were acquired from the National Archives of Australia. Published histories were used as a guide to target the relevant log pages. The daily readings of longitude and latitude were used to determine to the nearest midnight the days on which the ship passed in and out of the operational area. For the voyages of HMAS *Sydney* and the escort ships, each voyage has one set of Vietnamese water dates. For the ships that served with the US Seventh Fleet, each deployment has a series of Vietnamese water dates corresponding to the periods spent off the coast of Vietnam. The Vietnamese water dates were then incorporated into the Study Roll for each individual according to their voyage allocation.

Thus, information available for analysis for Navy personnel serving on board HMA Ships included:

- each ship on which he is known to have served;
- *VEA* coverage dates for each voyage into the operational area; and
- dates in the Vietnam operational area waters during each voyage.

32 Small Ship Squadron

Individual Records of Service were reviewed for each identified member of the 32 Small Ship Squadron. On the Records of Service are recorded the date of arrival in Vietnam and, for the majority, the ship on which they served.

Their departure from Vietnam is also recorded. A data capture exercise was undertaken to review each Record of Service and enter onto the Study Roll the dates in Vietnam and the ship or ships indicated. Where no ship was indicated, but the posting unit was 32 Small Ship Squadron, an estimate based on the known ship in the operational area at that time was entered. The Records of Service do not show individual movements between estuary waters and land-based facilities. Therefore, for the purposes of this study, actual time in the operational area is taken as the period in Vietnamese waters.

Thus, information available for analysis for Army personnel serving on board 32 Small Ship Squadron vessels included:

- each ship on which he is known to have served;
- 'Special Service' coverage dates for each voyage into the operational area; and
- dates in the Vietnam operational area waters during each voyage.

3.3 Accuracy of data

Since the publication of the Nominal Roll of Vietnam Veterans, over 800 notifications of errors and omissions that were subsequently verified by Department of Defence. 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 Royal Australian Regiment's 7th and 8th Battalions was prompted by feedback from the battalion associations. The associations 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 Department of Defence 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	2263	15	0.7	10	0.4	43	1.9	49	2.1
8RAR	1122	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 publication 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]

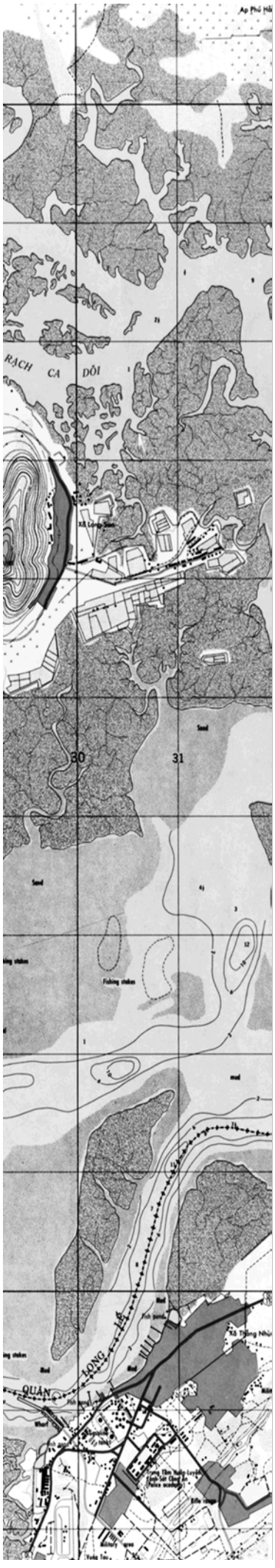
[a] 13 men served in more than one branch.

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 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.



4

Methods

Chapter 4 Methods

In the conduct of a cancer incidence study such as this one, three tasks are of paramount importance: compiling the Study Roll, determining the vital status of the cohort and investigating the cancer incidence of all participants. This chapter will discuss data sources and methods used for determining the vital status, and methods for calculating cancer incidence and investigation of number of cancers among subgroups within the cohort.

Determining whether a veteran is alive or dead (vital status) and, if dead, their date of death, is necessary to calculate the population at risk, that is, those veterans who could have got cancer.

A comparison between the incidence of cancer in Vietnam veterans and that of the male Australian community was carried out for a range of cancers and cancer groupings. Cancers were chosen because the study protocol identified them as being of particular concern, or because they were common in the Australian population or among the Vietnam veterans.

The statistical analysis of the Vietnam veteran cohort employed two standard statistical methods for cohort studies. The first method calculated the expected number of cancers of study participants in each year by applying the age and sex-specific cancer incidence rates of males in the Australian community to the study participants alive at each year from 1982 to 2000. The observed number of cancers among the study participants was then compared to the expected number of cancers to produce a Standardised Incidence Ratio (SIR), and tested for any statistically significant differences. The second method used regression modelling to assess the association between the number of cancers diagnosed and service characteristics among the Navy cohort.

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 subsequent 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 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

Cancer is a notifiable disease in all States and Territories. The data are collected by cancer registries and include 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 NCSCH was used as an additional check to determine the vital status of the study participants. The important data items for this purpose are names, date of birth and date of diagnosis. 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 believed 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 were thus 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 vital status information, matching to the NCSCH and Victorian Cancer Registry provided information on cancer diagnosis and date of diagnosis as discussed in Section 4.6.2.

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 97.5% of the cohort and 2.5% were lost to follow-up. Of the 2.5% lost to follow-up, 417 or 0.7% 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 2000.

Table 4-4: Summary results of matching

Service branch	Alive		Dead		Unknown		Total
Navy	11,648	86.0%	1,491	11.0%	399	2.9%	13,538
Army	35,944	87.5%	4,180	10.2%	960	2.3%	41,084
Air Force	3,764	82.4%	711	15.6%	95	2.1%	4,570
All personnel	51,343	86.8%	6,382	10.8%	1,454	2.5%	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.

In this study, the Air Force and the Army had the lowest proportion of subjects lost to follow-up (2.1% and 2.3% respectively). The figure was higher for the Navy at 2.9%.

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.

As discussed in section 4.6, only those alive at the start of the study period (1982) are included in the cancer incidence analysis. Of the total cohort of 59,179 veterans, 1,315 (2.2%) died prior to 1982. Further details of the number of veterans eligible for the study in each subgroup analysed are discussed in Chapter 6.

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, immigration records and pre 1980 deaths held at the State and Territory RBDMs.

Overall, 86.8% of the cohort was determined to be alive and 10.8% were accepted as having died including 2.2% who died before the study period. This left 2.5% of the veteran cohort for whom vital status remained unknown at the end of the study period.

The 1,454 veterans with an unknown vital status were not in contact with DVA after 31 December 2000, 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 2000 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 2000, 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 1,454 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 years, the vital status of 2.5% remained unknown.

4.6 Statistical methods

4.6.1 Population at risk

Vietnam veterans became part of the population at risk if they were alive at the beginning of the study period (1 January 1982). They contributed person-time until the study end date (31 December 2000) 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 12 person years to the population at risk. Similarly, a veteran who was alive throughout the study period would contribute 19 person years to the population at risk

The length of time each cohort member was alive during the period of observation from 1982 to 2000 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 = 1,454) 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 incidence rate of those lost to follow-up is substantially different, then the SIR 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 2000. The effect of including veterans whose status is unknown is that the expected number of cancers may be over-estimated and thus the estimate of the SIR 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.

4.6.2 Cancer incidence amongst veterans

The identification of cancer amongst veterans was determined by matching the Study Roll against the NCSCH. This identified all cases of cancer diagnosed between 1982 and 2000, apart from non-melanocytic skin cancers, which are not routinely reported to the cancer registries. An individual may experience more than one type of cancer, and each of these is recorded on the NCSCH, and is included in this analysis.

The expected number of cases of cancer by type of cancer was calculated for each year by applying five-year age incidence rates of cancer 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 incidence rates for the Australian male population for each cancer being studied, by five-year age groups, for each year from 1982 to 2000.
- Derive the population of living Vietnam War veterans (population at risk) by 5-year age groups from 1982 to 2000, from the Study Roll of Vietnam War veterans.
- Calculate the expected number of cases of the cancer being studied, had veterans experienced the cancer incidence rates of the general Australian population for each year 1982 to 2000. This was done by multiplying the age-specific incidence 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 cases for the 1982 to 2000 study period.

It should be noted that the observed and expected numbers for particular cancers can be aggregated to whatever group of cancers required. For example, the observed and expected numbers for head and neck cancers can be added to the observed and expected numbers for larynx cancer to obtain the observed and expected cases of oropharynx and larynx cancer. Commonly used groupings and selected subsets of interest have been included in the tables.

4.6.3 Cancer incidence analysis

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

A SIR of 1.0 means that there is no difference in cancer incidence between the Vietnam War veterans and the Australian community. A 95% CI which does not include the value 1.0 indicates that the calculated SIR 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 SIR 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 cancers diagnosed was small (< = 20), when the exact method[7] was used.

The SIR 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 SIR of 1.0 indicating no difference in cancer incidence. Horizontal lines for individual cancers consist of a central dot showing the SIR for the cancer and a horizontal error bar showing the 95% CI. Small error bars indicate good precision. The number of observed cancers 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 cancers that are significantly more common than expected and those wholly to the left of the vertical line indicate cancers that are significantly less common than expected.

4.7 Statistical power

In addition to SIRs 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 cancer 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 cancer 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 cancer incidence for the Vietnam veteran cohort compared to the Australian population. This reveals that the standardised incidence rate must exceed 18 per 100,000 per year for the study to have an 85% chance of detecting a 20% increase in relative risk (i.e. an SIR 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 13,000 (See Chapter 5), the standardised incidence rate must exceed 80 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 incidence rate would need to exceed 230 per 100,000 per year.

4.8 Regression analysis

Regression models with Poisson errors[8 9] were developed to investigate two broad issues:

- the association between the number of cancers diagnosed and service on a specific ship or type of ship (ship model), and
- the association between the number of cancers diagnosed and time in Vietnamese waters (Vietnamese water model).

4.8.1 Ship model

For the ship model, the outcome of number of cancers was assessed by ship or type of ship served compared to an internal Navy control group and controlled for age and total number of voyages. For the purposes of this analysis, HMAS *Melbourne* was classified as the internal Navy control, as this ship, although having Vietnam operational service, did not serve close to the Vietnamese coast and thus would not have been exposed to any potential chemical contamination from that source. The resulting analysis compares the number of cancers among

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

Cancer (ICD-10)	Standardised Incidence Rate[a]	% Probability of detecting a significant difference in incidence of a given cancer									
		SIR (Ratio of difference in cancer incidence in study population)									
		1	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	2
All neoplasms (C00-C97)	474.6	5.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Brain (C71)	7.4	5.0	22.2	52.9	80.9	95.0	99.1	99.9	100.0	100.0	100.0
Head and neck (C00-C14)	13.6	5.0	32.5	75.3	96.2	99.8	100.0	100.0	100.0	100.0	100.0
Colorectal (C18-C21)	66.7	5.0	84.4	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Pancreas (C25)	9.4	5.0	25.7	61.5	88.4	98.0	99.8	100.0	100.0	100.0	100.0
Bladder (C67)	22.9	5.0	46.2	91.6	99.7	100.0	100.0	100.0	100.0	100.0	100.0
Melanoma (C43)	46.4	5.0	71.4	99.6	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Brain (C71)	7.5	5.0	22.4	53.4	81.4	95.2	99.2	99.9	100.0	100.0	100.0
Prostate (C61)	109.5	5.0	96.2	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Trachea, bronchus and lung (C33, C34)	58.2	5.0	79.8	99.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Leukaemia (C91-C95)	13.2	5.0	31.9	74.2	95.8	99.7	100.0	100.0	100.0	100.0	100.0
Non-Hodgkin's lymphoma (C82, C83, C85)	18.7	5.0	40.3	86.2	99.1	100.0	100.0	100.0	100.0	100.0	100.0

[a] For males per 100,000 per year. Source: Cancer in Australia 1998 AIHW publication.

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

Assumptions:			
	Australian males	Number of individuals in comparison population	9000000
	Vietnam Veterans	Number of exposed participants in the study population	58000
		Length of time of follow-up of the study population (years)	19
		All participants traced	

those who served on a specific ship or type of ship to those who had their Vietnam Navy service on HMAS *Melbourne*. The ship model was restricted to those who served on one ship only. As discussed in Chapter 5, this comprised 71% of the Navy cohort.

Results for the ship model are given as a rate ratio, that is, the ratio of the rate of cancer for the group of interest compared to the rate of cancer in HMAS *Melbourne* control group and controlled for by the other explanatory variables of age and total number of voyages. As with the SIR described above, if the 95% CI excludes 1.0 then the rate in the study group is significantly different from that in the comparison group.

4.8.2 Vietnamese water model

For the Vietnamese water model, the outcome of number of cancers was assessed by the time spent on board ship in Vietnamese waters. As discussed in Chapters 5 and 6, the time in Vietnamese waters was highly correlated with the type of ship served. Therefore to analyse the effect of time in Vietnamese waters, a matrix of days in Vietnamese water by ship type was constructed for each Navy veteran. For every Navy veteran the total number of days in Vietnamese waters was categorised by number of days on gunline service, number of days on logistic/escort service, number of days on HMAS *Melbourne* service, and number of days on cargo ship service. Thus, an individual Navy veteran could have served Vietnamese water days on a single ship, on several ships within one category, or on ships across several categories. An example of this matrix is illustrated in Table 4-6. This analysis was controlled by age, total number of ships served and total number of voyages. As this analysis was investigating effect of days in Vietnamese waters on board ships, those who served in in-country units were excluded.

Table 4-6: Example of matrix for days in Vietnamese water by ship type

Total Vietnamese water days	HMAS *Melbourne* days	Gunline days	Logistic / escort days	Cargo ship days
1	1	0	0	0
10	0	0	10	0
95	0	94	1	0
37	0	0	0	37
3	1	0	2	0
7	0	0	1	6

The results for the water model are given as the β-coefficients for the regression equation for the days in Vietnamese waters by ship type variables. If the 95% CI for the β-coefficient excludes zero, this indicates a statistically significant association. The association between cancer incidence and days in Vietnamese

waters was assessed using the maximum likelihood test comparing the full model with all variables to the restricted model without the water days by type of ship variables.

4.9 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[10] Release 8.2. Tables of observed and expected cases of cancer and the standardised incidence ratios were compiled in EXCEL[11] 2003 and DeltaGraph[12] Version 5.0.1 was used to produce the graphs.

Data transformation in preparation for regression analysis was performed primarily using SPSS[13] statistical software and statistical analyses were primarily performed using STATA[14].

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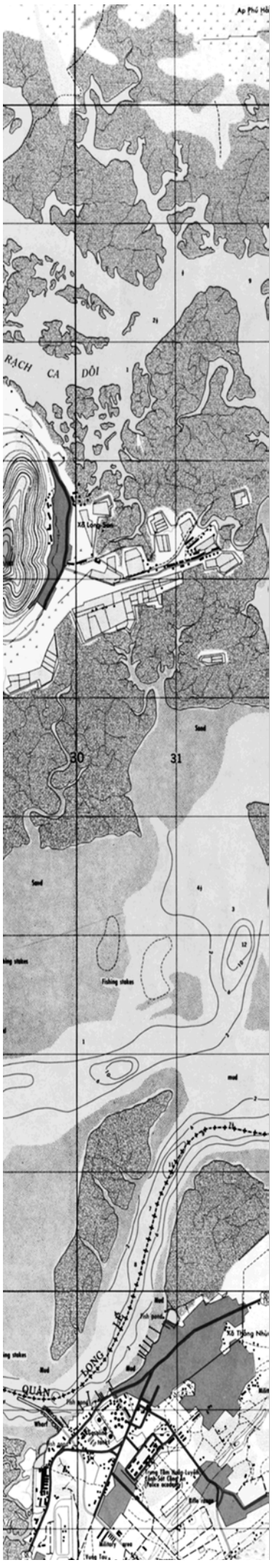


5

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. As described in the previous chapter and detailed in Chapter 6, the study cohort is the population at risk at the start of the cancer incidence study, that is those who were alive at 1 January 1982. Thus the study cohort (n = 57,864) is a subset of the cohort of military Vietnam veterans described in this chapter.

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.

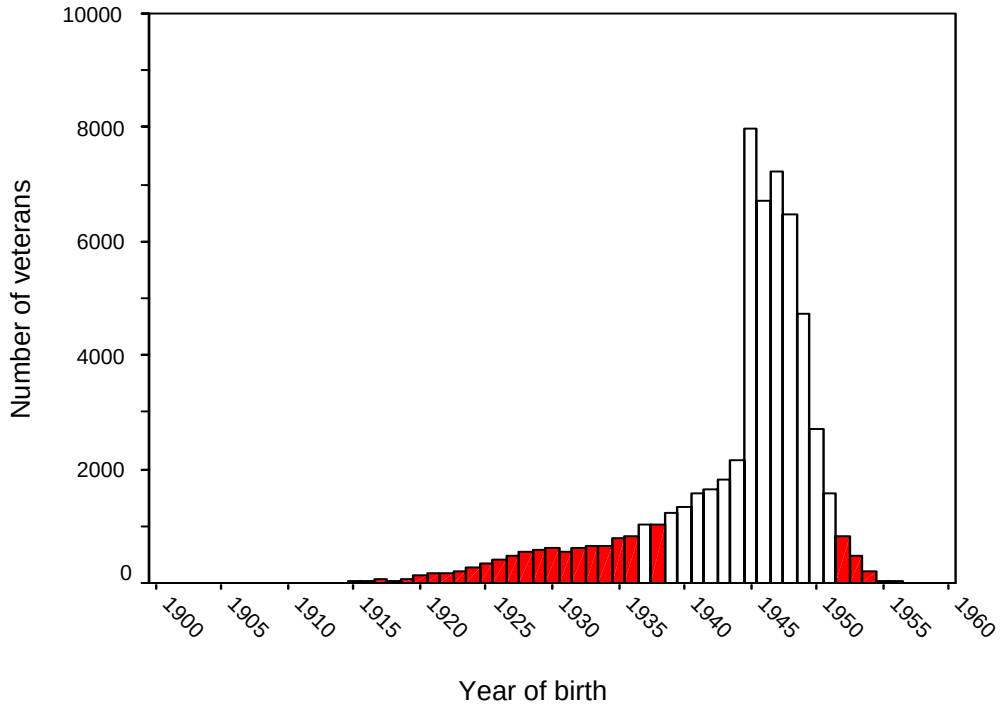


Figure 5-1: Number of Vietnam veterans by birth year

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.

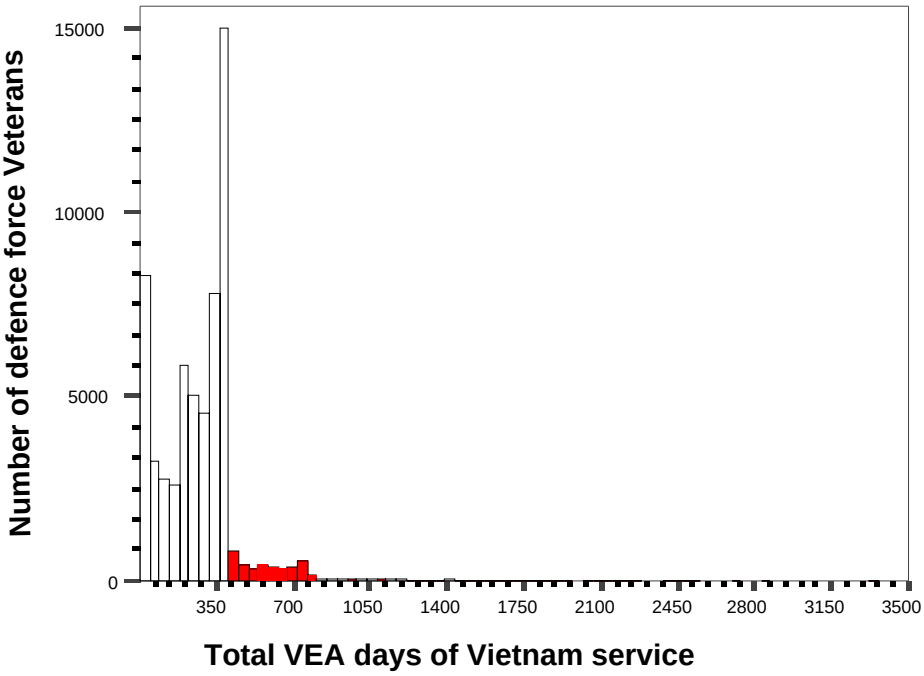


Figure 5-2: Duration of Vietnam service for defence force Vietnam veterans

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
32 Small Ship Squadron				
VEA days	187.4 ± 6.84	151	6 – 1295	254
Vietnamese water days	117.3 ± 4.56	108	3 – 801	166
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.

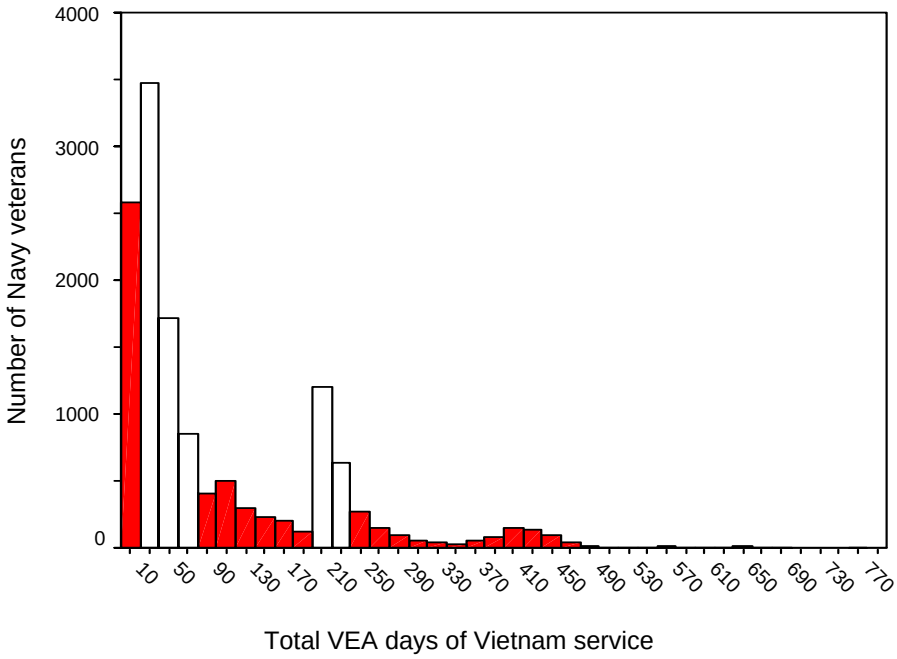


Figure 5-3: Total number of VEA days of Vietnam service for Navy veterans

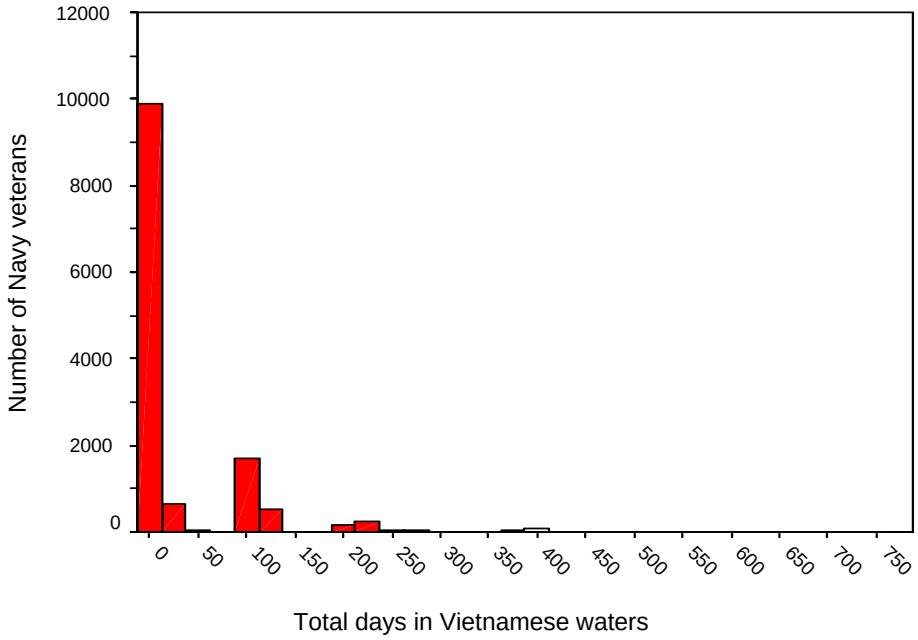


Figure 5-4: Total number of days in Vietnamese waters for Navy veterans

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.

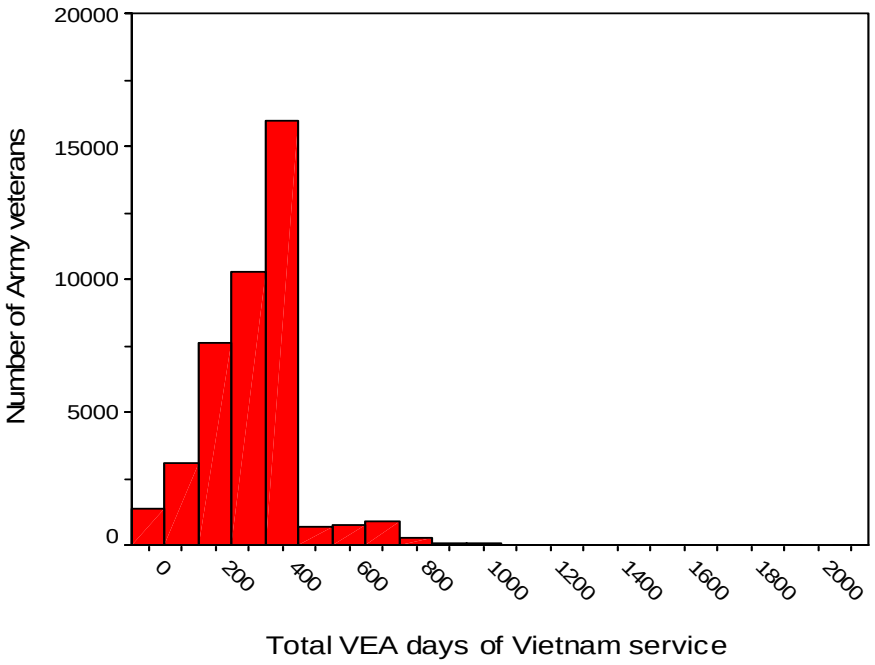


Figure 5-5: Total number of VEA days for all Army veterans

Duration of Army 32 Small Ship Squadron Service

The 32 Small Ship Squadron was a ship-based unit within the Army. Five hundred and ninety-seven Army veterans have been identified as serving on board 32 Small Ship Squadron vessels. The time in Vietnam was calculated as VEA days and days in Vietnamese waters (Table 5-3). The latter dates were determined by examination of individual service records. Figure 5-6 shows the distribution of VEA days. The average duration of service for this unit was less than for Army as a whole.

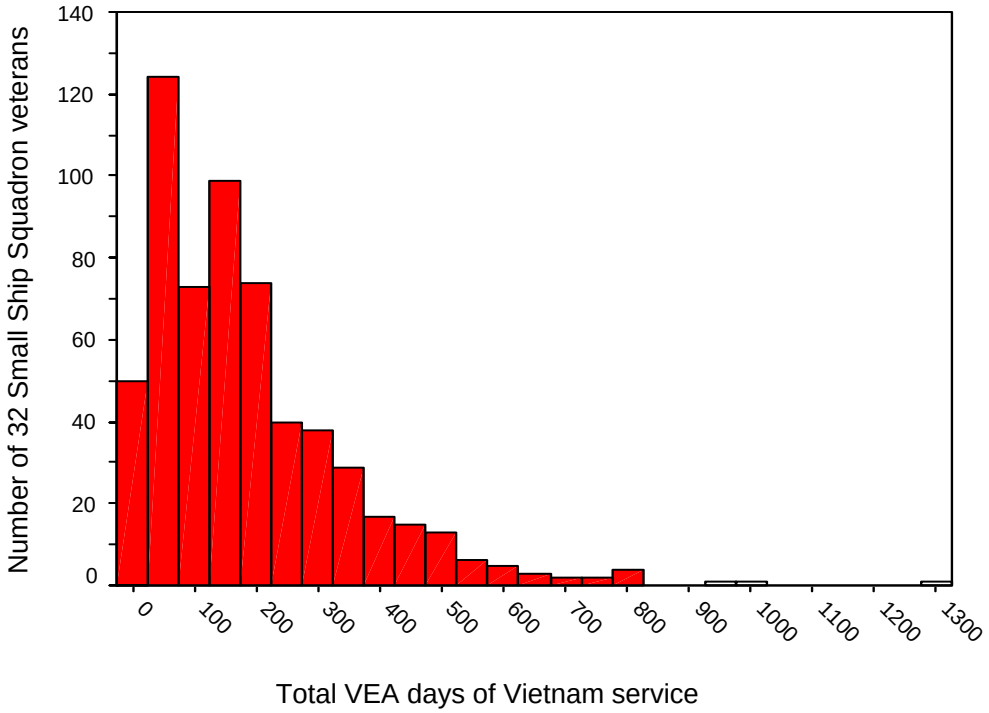


Figure 5-6: Total number of VEA days for Army 32 Small Ship Squadron veterans

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.

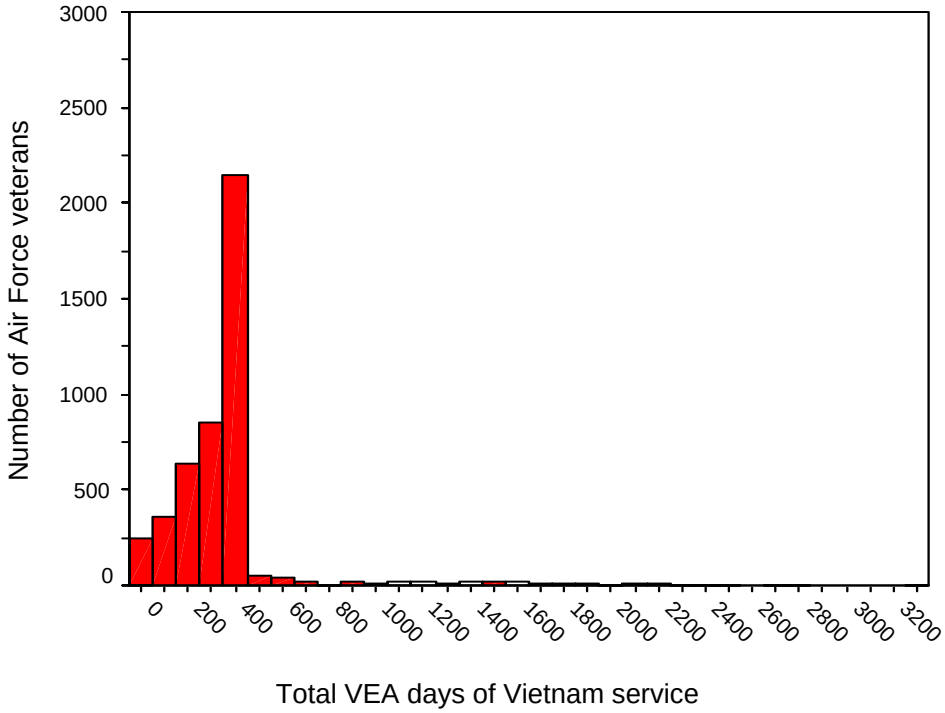


Figure 5-7: Total number of VEA days for Air Force veterans

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

Army 32 Small Ship Squadron

Five small ships made up the 32 Small Ship Squadron. Four ships, the AV *Clive Steele*, *Harry Chauvel*, *Brudenell White* and *Vernon Sturdee*, were Landing Ship Medium (LSM), which obtained potable water by both evaporative distillation on the ship and land re-supply. The fifth ship, the AV *John Monash*, was a cargo ship with no on-board distillation equipment and so procured potable water from land re-supply only. These five ships did a total of 24 voyages. Table 5-7 shows the service on these ships. Sixty-five veterans of the 597 who served in the 32 Small Ship Squadron also served in other Army units. Personnel in this unit served on an average of 1.4 ships, (range 1-4) and completed an average of 2.2 tours, (range 1-11).

Table 5-7: Service on ships of the 32 Small Ship Squadron

Ship	Number of voyages	Number served [a]	Percentage
AV *Brudenell White*	1	49	5.8
AV *Clive Steele*	7	325	38.8
AV *Harry Chauvel*	3	127	15.2
AV *John Monash*	11	200	23.9
AV *Vernon Sturdee*	2	136	16.2
Total	**24**	**838**	**100.0**

[a] 32 Small Ship Squadron 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 5-8: 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 5-9: 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%)**

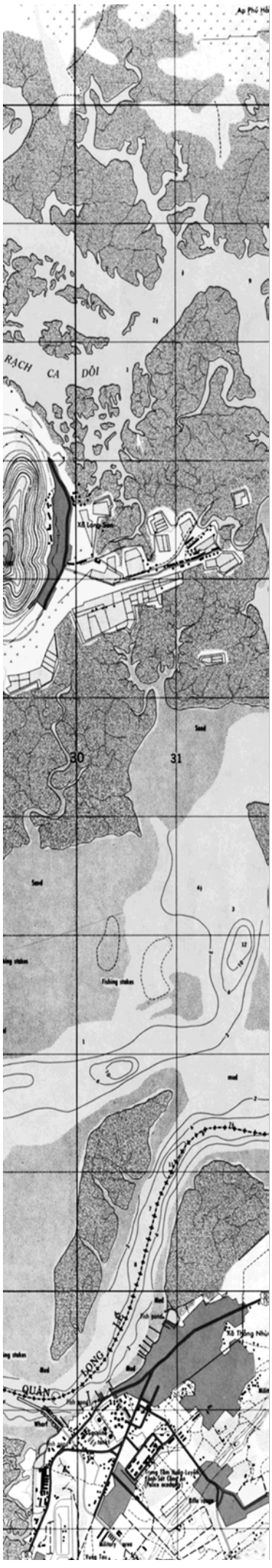
5.5 Summary

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 cancer incidence analysis. This analysis compares the incidence of cancers diagnosed among Vietnam veterans between 1982 and 2000 to the incidence of cancer in the male Australian population. This chapter focuses on those results of *a priori* interest, as per the protocol (Appendix A), and results that are substantially different from the Australian population. In addition, cancer incidence analysis by Service branch and for specific groups of veterans is also presented. The complete results of the cancer incidence analysis are tabled in Appendix C. Finally the results of regression analyses which investigate the association between the number of cancers diagnosed and service characteristics of Navy veterans is presented.

6.1 Overview of analysis

Two broad types of analyses were used to assess cancer incidence among Vietnam veterans: calculation of standardised incidence ratios (SIRs) and regression modelling.

As described in Chapter 4, the SIR is the ratio of observed cancers among Vietnam veterans to the expected number of cancers among male Australians of the same age in the same time period. Due to the uncertainty of the vital status of the 2.5% of veterans lost to follow-up, the SIR 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 incidence rate of those lost to follow-up is substantially different, then the SIR using this scenario may 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 2000. The effect of including veterans whose status is unknown is that the expected number of cancers 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 SIRs by themselves is insufficient for determining whether veterans experienced significantly higher or lower rates of cancer than might be expected. Calculation of the 95% CI is used to determine whether the higher or lower rates of cancer experienced by veterans are 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 a one in twenty probability the result could 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 cancer influence statistical power. Thus in this chapter SIR results which are statistically significantly different from the Australian population are presented. Results that differ non-significantly by more than 10% are also presented. This is not a suggestion that these variations represent real differences but rather is a means to provide the reader with a broader picture of cancer patterns. Complete results are tabled in Appendix C.

Regression modelling was used to investigate the association between service characteristics and the number of cancers diagnosed among different groups of Navy veterans. It incorporates service characteristics, such as the ship or type of ship on which the veteran served, time in Vietnamese waters and number of voyages completed, into the analysis to assess the relationship between the number of cancers among these subgroups and these service parameters.

6.1.1 Number of veterans contributing to the analysis

The cancer incidence analysis is for the period 1982-2000, the period for which there is complete cancer incidence data through the NCSCH. Only those veterans alive at the start of the study are included in the cancer incidence analysis. As discussed in Chapter 3, 59,176 male Vietnam veterans are on the Study Roll. Of these, 1,315 (2.2%) died prior to the start of the study in 1982 leaving 57,864 veterans for the cancer analysis. Of these, the status of 1,037 was unknown at the start of the study period. During the study period 4,442 (7.7%) died and 1,454 (2.5%) were of unknown vital status at the end of follow-up.

Cancer incidence is also assessed for a number of subgroups of veterans. Cancer incidence by Service branch is discussed in Section 6.5. Table 6.4 details the number of veterans in each Service branch who contribute to the analysis. Section 6.7 investigates cancer incidence among veterans who served in specific units. Those who only served in the unit of interest are included in this analysis and are therefore a subgroup of all who served in a specific unit.

6.2 Observed cancers in Vietnam veterans

Of the 4,590 cancers diagnosed among Vietnam veterans between 1982 and 2000, melanoma and, cancers of the prostate, colon and rectum and lung were the most common cancers, comprising 58% of all cancers diagnosed. Table 6-1 lists the 15 most common cancers observed among Vietnam veterans and the expected number for the Australian population.

Table 6-1: Most common cancers among Vietnam veterans 1982–2000

Type of cancer	Observed Number of cancers	Per cent of total cancers among veterans	Expected Number of cancers (%)
Melanoma	756	16.5	573 (14.4%)
Prostate	692	15.1	553 (13.9%)
Colorectal	622	13.6	580 (14.6%)
Lung	576	12.5	468 (11.8%)
Head and Neck	247	5.4	167 (4.2%)
Bladder	164	3.6	157 (3.9%)
Unknown Primary site	143	3.1	135 (3.4%)
Leukaemia	130	2.8	110 (2.8%)
Non-Hodgkin's Lymphoma	126	2.7	189 (4.7%)
Kidney	125	2.7	124 (3.1%)
Stomach	104	2.3	116 (2.9%)
Brain	97	2.1	91 (2.3%)
Larynx	97	2.1	66 (1.7%)
Pancreas	86	1.9	75 (1.9%)
Testis	54	1.2	62 (1.6%)
All cancers	**4,590**	**100%**	**3977 (100%)**

6.3 Cancers of *a priori* interest

Several cancers were of specific interest to this study because they were suggested to be of a concern for Vietnam veterans through a review of the literature or through discussions with the veteran community. Table 6-2 gives SIRs for those cancers of *a priori* interest.

The incidence rate for all cancers was significantly higher than expected for Vietnam veterans in both scenarios. Of the 16 cancers of *a priori* interest, the rates of five (cancers of the head and neck, lung, prostate, Hodgkin's disease and melanoma) were significantly higher than expected. The rates of four cancers (liver, thyroid, multiple myeloma and non-Hodgkin's lymphoma) showed a lower than expected incidence. The incidence of all other cancers of *a priori* interest was not significantly different from the Australian population.

Table 6-2: Standardised Incidence Ratios (SIRs) for cancers of *a priori* interest for the Vietnam veteran cohort

Cancer [a]	Number of cancers	Scenario 1 (Unknowns Excluded)		Scenario 2 (Unknowns Included)	
		SIR	95% CI	SIR	95% CI
All cancers	4,590	1.15	1.12, 1.19	1.13	1.09, 1.16
Bladder	164	1.04	0.88, 1.20	1.02	0.86, 1.17
Brain	97	1.07	0.85, 1.28	1.04	0.84, 1.25
Breast	7	0.90	0.36, 1.86	0.88	0.35, 1.81
Gastrointestinal	743	1.05	0.97, 1.12	1.02	0.95, 1.09
Head and neck [b]	247	1.48	1.29, 1.66	1.44	1.26, 1.63
Hodgkin's disease	51	2.05	1.49, 2.61	2.01	1.45, 2.56
Liver	27	0.70	0.44, 0.97	0.69	0.43, 0.95
Leukemia	130	1.18	0.98, 1.38	1.15	0.95, 1.35
Lung	576	1.23	1.13, 1.33	1.20	1.10, 1.30
Melanoma	756	1.32	1.23, 1.41	1.29	1.20, 1.38
Multiple myeloma	31	0.66	0.43, 0.90	0.65	0.42, 0.88
Non-Hodgkin's lymphoma	126	0.67	0.55, 0.79	0.65	0.54, 0.77
Prostate	692	1.25	1.16, 1.34	1.21	1.12, 1.31
Soft tissue and other sarcoma	35	0.99	0.66, 1.31	0.96	0.64, 1.28
Testis	54	0.87	0.63, 1.10	0.85	0.62, 1.07
Thyroid	17	0.57	0.33, 0.92	0.56	0.33, 0.90

[a] Shading indicates statistical significance. The darker shading indicates a lower than expected incidence and the lighter shading a higher than expected incidence. Complete results are in Appendix C.
[b] Head and Neck cancer includes cancer of the tongue, gum, mouth, palate, salivary glands, tonsil, oropharynx and nasopharynx.

6.4 Cancer incidence in Vietnam veterans

There were a total of 4,590 cancers diagnosed and the incidence for all cancers was elevated between 13-15%. Figure 6-1 shows the SIRs and 95% CIs for the cancers analysed. Interpretation of the figures is explained in Section 4.6.3.

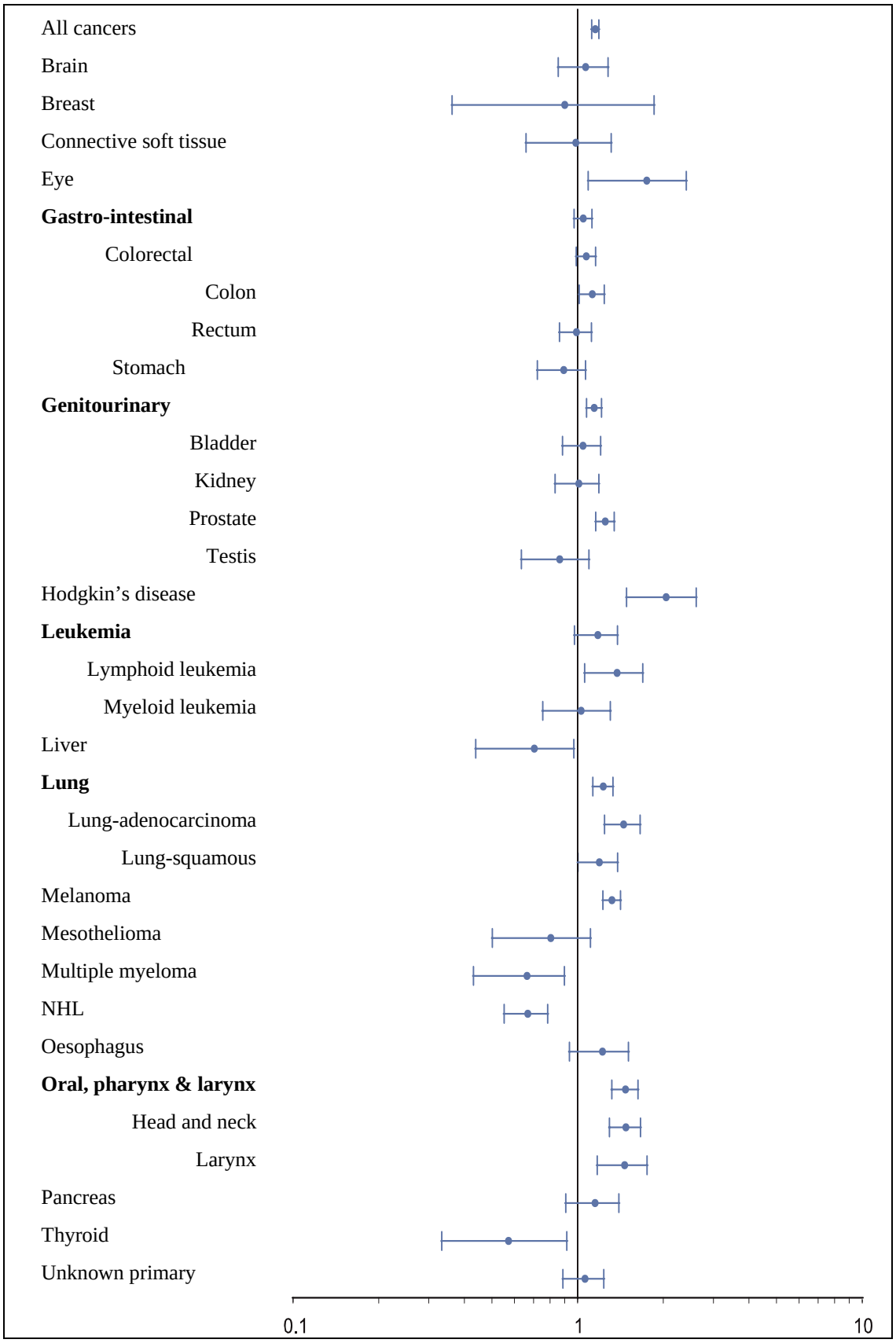


Figure 6-1: Standardised Incidence Ratios (SIRs) and CIs for Vietnam veteran cohort.

6.4.1 Cancers with a substantially higher than expected SIR

Table 6-3 lists those cancers for which the incidence was more than 10% higher than expected among Vietnam veterans. The incidence of Hodgkin's disease was more than double the expected rate. The incidence of eye cancer was 71-75% higher than expected and the rate of leukaemia was also elevated, primarily due to a more than 50% increase in the risk of chronic lymphoid leukaemia. Other cancers that had significantly higher than expected incidence include: melanoma and cancers of the colon (Scenario 1 only), lung and genitourinary system (primarily prostate cancer) and cancers of the oral cavity, pharynx and larynx.

Table 6-3: Standardised Incidence Ratios (SIRs) which were substantially higher than expected: Male defence force Vietnam veterans

Cancer [a]	Number of cancers	Scenario 1 (Unknowns Excluded)		Scenario 2 (Unknowns Included)	
		SIR	95% CI	SIR	95% CI
All Cancers	4,590	1.15	1.12, 1.19	1.13	1.10, 1.17
Colon	376	1.13	1.01, 1.24	1.10	0.99, 1.21
Eye	27	1.75	1.09, 2.41	1.71	1.06, 2.35
Genitourinary	1,055	1.14	1.08, 1.21	1.11	1.05, 1.18
Prostate	692	1.25	1.16, 1.34	1.21	1.12, 1.31
Hodgkin's disease	51	2.05	1.49, 2.61	2.01	1.45, 2.56
Leukaemia	130	1.18	0.98, 1.38	1.15	0.95, 1.35
Lymphoid Leukaemia	72	1.38	1.06, 1.69	1.34	1.03, 1.65
Lymphoid – acute	9	1.29	0.59, 2.44	1.26	0.58, 2.39
Lymphoid – chronic	58	1.55	1.15, 1.95	1.51	1.12, 1.90
Myeloid Leukaemia – chronic	21	1.20	0.69, 1.71	1.17	0.67, 1.67
Lung	576	1.23	1.13, 1.33	1.20	1.10, 1.30
Melanoma	756	1.32	1.23, 1.41	1.29	1.20, 1.38
Oesophagus	70	1.22	0.94, 1.51	1.19	0.91, 1.47
Oral cavity, pharynx & larynx	344	1.47	1.32, 1.63	1.44	1.29, 1.59
Head and neck [b]	247	1.48	1.29, 1.66	1.44	1.26, 1.63
Larynx	97	1.46	1.17, 1.75	1.43	1.14, 1.71
Pancreas	86	1.15	0.91, 1.40	1.12	0.89, 1.36

[a] Shading indicates statistical significance. Complete results are in Appendix C.
[b] Head and neck cancer includes cancer of the tongue, gum, mouth, palate, salivary glands, tonsil, oropharynx and nasopharynx.

6.4.2 Cancers with a substantially lower than expected SIR

Although cancer incidence was elevated overall, there were four cancers (liver, thyroid, multiple myeloma and non-Hodgkin's lymphoma) for which the cancer incidence rate was significantly lower than expected. Table 6-4 shows the results for those cancers that were statistically significantly lower than expected or the SIR was more than 10% non-significantly lower than expected.

Table 6-4: Standardised Incidence Ratios (SIRs) which were substantially lower than expected: Male defence force Vietnam veterans

Cancer [a]	Number of cancers	Scenario 1 (Unknowns Excluded)		Scenario 2 (Unknowns Included)	
		SIR	95% CI	SIR	95% CI
Liver	27	0.70	0.44, 0.97	0.69	0.43, 0.95
Mesothelioma	27	0.81	0.50, 1.11	0.79	0.49, 1.08
Multiple myeloma	31	0.66	0.43, 0.90	0.65	0.42, 0.88
Non-Hodgkin's Lymphoma	126	0.67	0.55, 0.79	0.65	0.54, 0.77
Stomach	104	0.89	0.72, 1.07	0.87	0.70, 1.04
Testis	54	0.87	0.63, 1.10	0.85	0.62, 1.07
Thyroid	17	0.57	0.33, 0.92	0.56	0.33, 0.90

[a] Shading indicates statistical significance. Complete results are in Appendix C.

6.5 Cancer incidence by branch of Service

Cancer incidence was investigated by Service branch. Table 6-5 summarises the number of cancers and person years that contributed to the analysis. Tables C.2 to C.5 in Appendix C summarise the SIRs and 95% CIs for all cancer sites studied for the three Service branches. The following sections discuss the results for individual Service branches.

Table 6-5: **Number of cancers and person years contributed by branch of Service**

Service branch	Alive at start of study	Alive at end of study	Unknown at start of study	Unknown at end of study [a]	Cancers	Person Years contributed	
						Unknowns excluded	Unknowns included
Navy	12,935	11,799	298	399	1,073	237,249	243,378
Army	39,517	36,347	673	960	3,013	727,153	741,456
Air Force	4,388	3,835	66	95	505	79,147	80,553
Total [b]	56,827	51,968	1,037	1,454	4,590	1,043,302	1,065,140

[a] The increase in unknowns from the start of the study to the end of the study are those veterans who were known to be alive at some time during the study period but their vital status was not known by the end of the study period.
[b] 13 veterans served in two service branches therefore totals do not equal the sum of the Service branches.

6.5.1 Navy Vietnam veterans

There were 1,073 cancers diagnosed among the 12,935 Navy Vietnam veterans. The overall incidence for all cancers was elevated between 22 to 26%. Figure 6-2 shows the SIRs and 95% CIs for the cancers analysed.

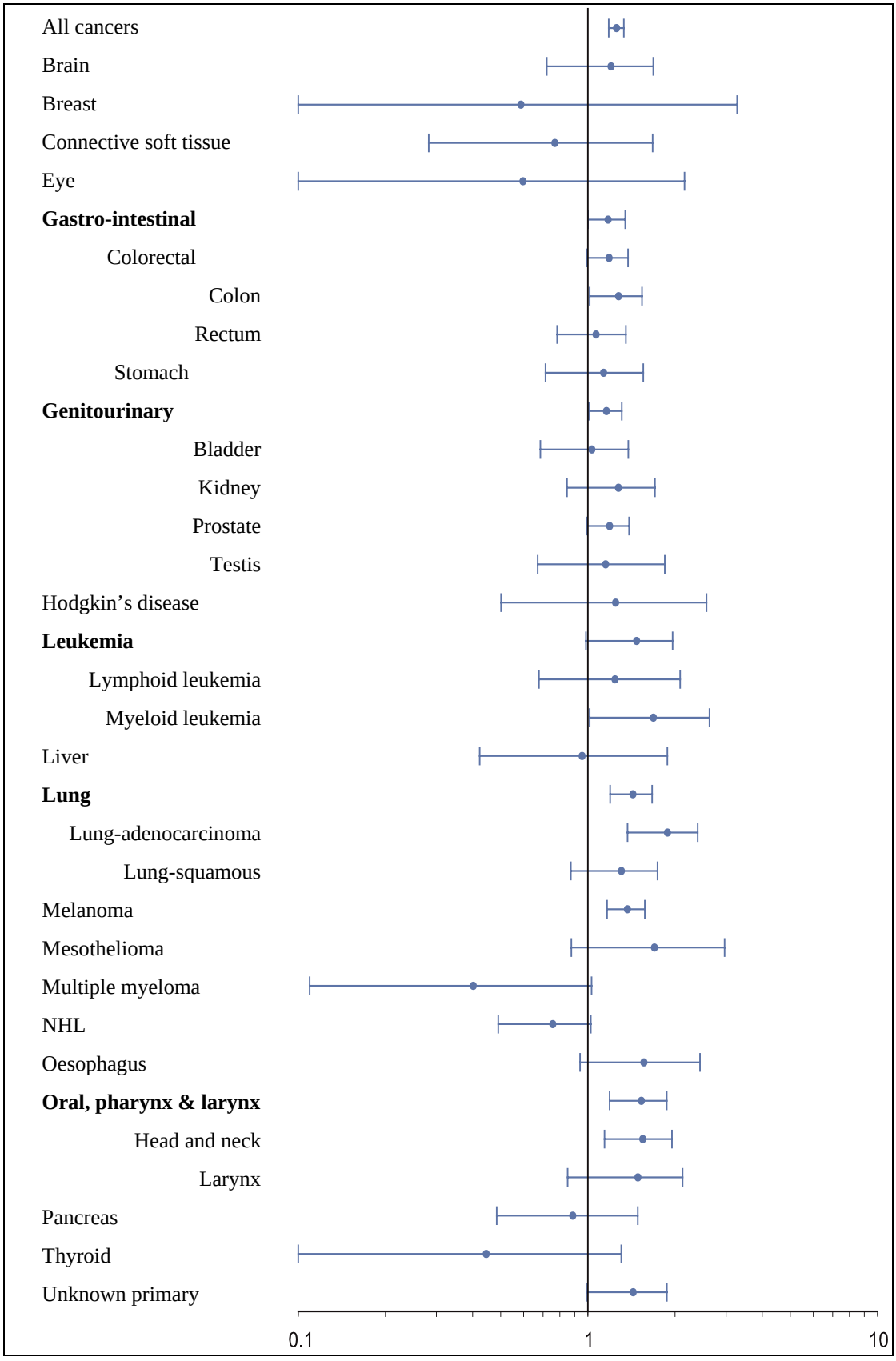


Figure 6-2: Standardised Incidence Ratios (SIRs) and CIs for Navy Vietnam veterans

Cancers with a substantially higher than expected SIR

Table 6-6 lists those cancers that were substantially higher than expected among the Navy cohort. The incidence of genitourinary cancer, gastrointestinal cancer (specifically colon cancer) and myeloid leukaemia were significantly higher than expected in Scenario 1 only. The incidence of cancers of the lung and oral cavity, pharynx and larynx and melanoma were 35-55% significantly higher than expected in both scenarios. Rates of leukaemia and other cancers including brain, Hodgkin's disease, and oesophagus were 20-50% higher than expected but these analyses were based on small numbers of cases and the increases were not statistically significant.

Table 6-6: Standardised Incidence Ratios (SIRs) which were substantially higher than expected: Navy Vietnam veterans

Cancer [a]	Number of cancers	Scenario 1 (Unknowns Excluded)		Scenario 2 (Unknowns Included)	
		SIR	95% CI	SIR	95% CI
All Cancers	1073	1.26	1.18, 1.33	1.22	1.15, 1.29
Brain	24	1.20	0.72, 1.68	1.17	0.07, 1.64
Gastrointestinal	178	1.17	1.00, 1.35	1.14	0.97, 1.31
Colon	91	1.28	1.01, 1.54	1.24	0.98, 1.49
Stomach	28	1.13	0.71, 1.55	1.10	0.69, 1.51
Genitourinary	226	1.16	1.01, 1.31	1.12	0.97, 1.27
Kidney	34	1.28	0.85, 1.70	1.24	0.82, 1.66
Prostate	137	1.19	0.99, 1.39	1.15	0.95, 1.34
Testis	17	1.15	0.67, 1.84	1.12	0.65, 1.80
Hodgkin's disease	7	1.25	0.50, 2.57	1.22	0.49, 2.50
Leukaemia	35	1.47	0.98, 1.96	1.43	0.96, 1.90
Lymphoid leukaemia	14	1.24	0.68, 2.08	1.20	0.66, 2.02
Lymphoid – chronic	12	1.51	0.78, 2.63	1.46	0.75, 2.55
Myeloid leukaemia	19	1.68	1.01, 2.63	1.63	0.98, 2.55
Myeloid – acute	11	1.79	0.89, 3.20	1.73	0.87, 3.10
Myeloid – chronic	8	2.09	0.92, 4.11	2.03	0.90, 3.99
Lung	141	1.43	1.19, 1.67	1.38	1.16, 1.61
Melanoma	173	1.37	1.17, 1.57	1.33	1.13, 1.53
Oesophagus	19	1.56	0.94, 2.44	1.51	0.91, 2.36
Oral cavity, pharynx & larynx	77	1.53	1.19, 1.87	1.49	1.15, 1.82
Head and neck [b]	56	1.55	1.14, 1.95	1.50	1.11, 1.90
Larynx	21	1.49	0.85, 2.12	1.44	0.83, 2.06
Unknown origin	41	1.43	1.00, 1.87	1.39	0.96, 1.82

[a] Shading indicates statistical significance. Complete results are listed in Appendix C.
[b] Head and Neck cancer includes cancer of the tongue, gum, mouth, palate, salivary glands, tonsil, oropharynx and nasopharynx.

Cancers with a substantially lower than expected SIR

The incidence of one cancer (non-Hodgkin's lymphoma) was significantly lower than expected among the Navy cohort in Scenario 2 only. The incidence of a number of other cancers was 11-60% lower than expected, however for some cancers this was based on very small numbers and the differences were not statistically significant. The results are listed in Table 6-7.

Table 6-7: **Standardised Incidence Ratios (SIRs) which were substantially lower than expected: Navy Vietnam veterans**

Cancer [a]	Number of cancers	Scenario 1 (Unknowns Excluded)		Scenario 2 (Unknowns Included)	
		SIR	95% CI	SIR	95% CI
Breast	1	0.59	0.01, 3.28	0.57	0.01, 3.18
Connective soft tissue	6	0.77	0.28, 1.67	0.75	0.27, 1.63
Eye	2	0.60	0.07, 2.16	0.58	0.07, 2.10
Leukaemia – acute lymphoid	1	0.63	0.02, 3.50	0.61	0.02, 3.41
Multiple myeloma	4	0.40	0.11, 1.03	0.39	0.11, 1.00
Non-Hodgkin's lymphoma	31	0.76	0.49, 1.02	0.74	0.48, 0.99
Pancreas	14	0.89	0.48, 1.49	0.86	0.47, 1.44
Thyroid	3	0.45	0.09, 1.30	0.43	0.09, 1.27

[a] Shading indicates statistical significance. Complete results are listed in Appendix C.

6.5.2 Army Vietnam veterans

There were 3,013 cancers diagnosed among the 39,517 Army Vietnam veterans. The overall incidence for all cancers was 11-13% higher than expected. Figure 6-3 shows SIRs and 95% CIs for the cancers analysed.

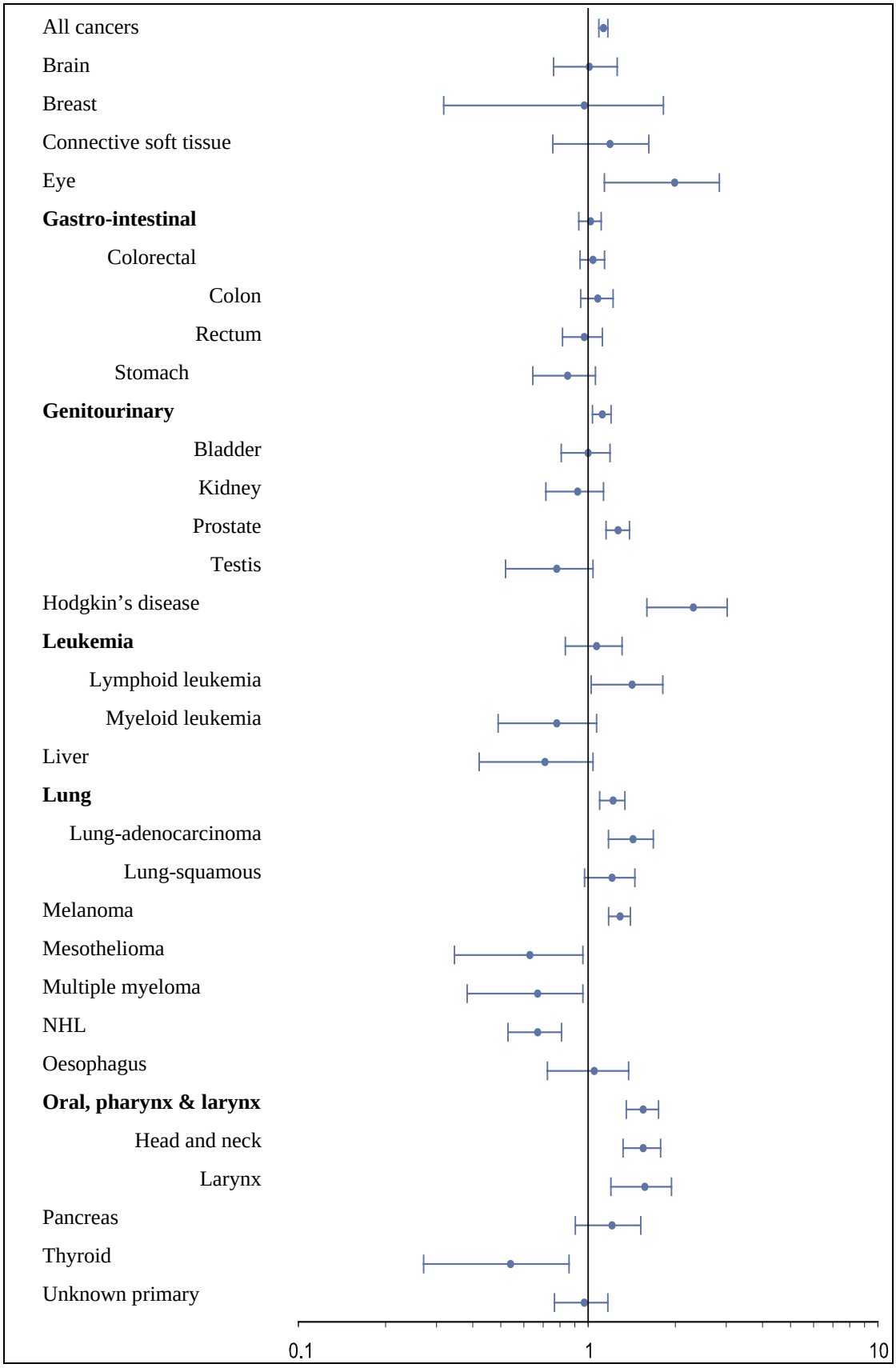


Figure 6-3: Standardised Incidence Ratios (SIRs) and CIs for Army Vietnam veterans

Cancers with a substantially higher than expected SIR

Table 6-8 lists those cancers that had a substantially higher than expected incidence among the Army Vietnam veterans. The incidence of Hodgkin's disease and cancer of the eye were double that of the Australian population. Lung cancer, cancers of the head and neck region and melanoma had higher than expected incidence. The incidence of genitourinary cancers (primarily prostate cancer) and lymphoid leukaemia (primary chronic lymphoid leukaemia) were also higher than expected. Cancers of the connective soft tissue and pancreas had 19-21% higher than expected incidence but this was not statistically significant.

Table 6-8: Standardised Incidence Ratios (SIRs) which were substantially higher than expected: Army Vietnam veterans

Cancer [a]	Number of cancers	Scenario 1 (Unknowns Excluded)		Scenario 2 (Unknowns Included)	
		SIR	95% CI	SIR	95% CI
All Cancers	3,013	1.13	1.09, 1.17	1.11	1.07, 1.15
Connective soft tissue	29	1.19	0.76, 1.63	1.17	0.74, 1.59
Eye	21	1.99	1.14, 2.84	1.95	1.11, 2.78
Genitourinary	678	1.12	1.04, 1.20	1.09	1.01, 1.18
Prostate	451	1.27	1.15, 1.38	1.23	1.12, 1.35
Hodgkin's disease	40	2.31	1.59, 3.02	2.26	1.56, 2.96
Leukaemia - lymphoid	50	1.42	1.03, 1.82	1.39	1.01, 1.78
Lymphoid - chronic	42	1.68	1.18, 2.19	1.65	1.15, 2.14
Lung	372	1.22	1.09, 1.34	1.19	1.07, 1.31
Melanoma	510	1.29	1.18, 1.41	1.27	1.16, 1.38
Oral cavity, pharynx & larynx	243	1.55	1.36, 1.75	1.52	1.33, 1.71
Head and neck [b]	174	1.55	1.32, 1.78	1.51	1.29, 1.74
Larynx	69	1.57	1.20, 1.94	1.54	1.18, 1.90
Pancreas	60	1.21	0.90, 1.51	1.18	0.88, 1.48

[a] Shading indicates statistical significance. Complete results are listed in Appendix C.
[b] Head and neck cancer includes cancer of the tongue, gum, mouth, palate, salivary glands, tonsil, oropharynx and nasopharynx.

Cancers with a substantially lower than expected SIR

Table 6-9 lists those cancers for which Army veterans had a substantially lower than expected incidence. The cancer incidence in Army veterans was significantly lower than expected for multiple myeloma, non-Hodgkin's lymphoma and thyroid cancer. The incidence of mesothelioma, myeloid leukaemia and cancers of the liver, stomach and testis were 15-37% lower than expected, but this was not statistically significant.

Table 6-9: Standardised Incidence Ratios (SIRs) which were substantially lower than expected: Army Vietnam veterans

Cancer [a]	Number of cancers	Scenario 1 (Unknowns Excluded)		Scenario 2 (Unknowns Included)	
		SIR	95% CI	SIR	95% CI
Liver	18	0.71	0.42, 1.12	0.69	0.41, 1.10
Leukaemia - Myeloid	28	0.78	0.49, 1.07	0.77	0.48, 1.05
Myeloid – acute	15	0.77	0.43, 1.27	0.75	0.42, 1.24
Myeloid – chronic	10	0.84	0.40, 1.54	0.82	0.39, 1.50
Mesothelioma	14	0.63	0.34, 1.05	0.61	0.33, 1.03
Multiple myeloma	21	0.67	0.38, 0.96	0.66	0.38, 0.94
Non-Hodgkin's lymphoma	86	0.67	0.53, 0.81	0.65	0.52, 0.79
Stomach	66	0.85	0.65, 1.06	0.83	0.63, 1.03
Testis	34	0.78	0.52, 1.04	0.76	0.51, 1.02
Thyroid	11	0.54	0.27, 0.96	0.53	0.26, 0.94

[a] Shading indicates statistical significance. Complete results are listed in Appendix C.

6.5.3 Air Force Vietnam veterans

Among the 4,388 Air Force Vietnam veterans, 505 cancers were diagnosed during the study period. The overall incidence of cancer was 6-8% higher than expected, but this was not statistically significant. Figure 6-4 shows SIRs and 95% CIs for the cancers analysed.

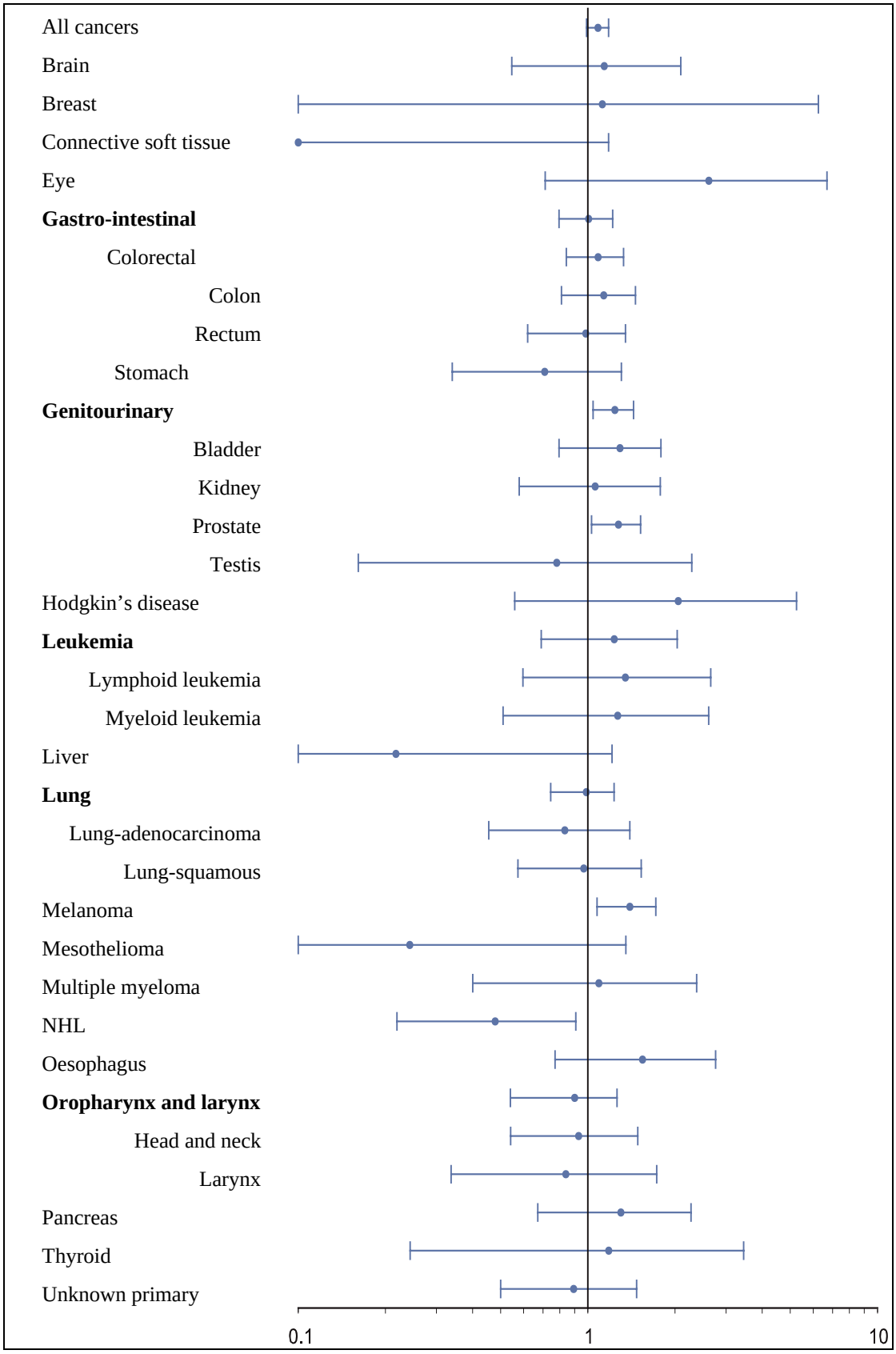


Figure 6-4: Standardised Incidence Ratios (SIRs) and CIs for Air Force Vietnam veterans

Cancers with a substantially higher than expected SIR

Table 6-10 lists those cancers among Air Force Vietnam veterans that were substantially higher than expected. The incidence of cancers of the genitourinary system, primarily prostate cancer, acute lymphoid leukaemia and melanoma was significantly higher than the Australian population. Although the number of cancers diagnosed was small, the rates of cancers of the brain, eye, colon, oesophagus, pancreas, thyroid, leukaemias and Hodgkin's disease were 13% to over 160% higher than expected. However, these results were not statistically significant.

Table 6-10: Standardised Incidence Ratios (SIRs) which were substantially higher than expected: Air Force Vietnam veterans

Cancer [a]	Number of cancers	Scenario 1 (Unknowns Excluded)		Scenario 2 (Unknowns Included)	
		SIR	95% CI	SIR	95% CI
Brain	10	1.14	0.55, 2.09	1.11	0.53, 2.05
Eye	4	2.61	0.71, 6.69	2.55	0.70, 6.54
Colon	47	1.13	0.81, 1.46	1.11	0.79, 1.42
Genitourinary	151	1.24	1.04, 1.44	1.20	1.01, 1.40
Prostate	104	1.28	1.03, 1.52	1.24	1.00, 1.47
Hodgkin's disease	4	2.05	0.56, 5.25	2.01	0.55, 5.15
Leukaemia	15	1.23	0.69, 2.03	1.20	0.67, 1.98
Lymphoid leukaemia	8	1.35	0.60, 2.66	1.31	0.58, 2.59
Lymphoid – acute	3	5.10	1.05, 14.90	4.98	1.03, 14.57
Myeloid leukaemia	7	1.27	0.51, 2.61	1.23	0.50, 2.54
Myeloid – acute	4	1.27	0.35, 3.26	1.24	0.34, 3.18
Myeloid – chronic	3	1.77	0.36, 5.17	1.73	0.36, 5.05
Melanoma	73	1.40	1.08, 1.72	1.37	1.05, 1.68
Oesophagus	11	1.54	0.77, 2.76	1.50	0.75, 2.69
Pancreas	12	1.30	0.67, 2.27	1.27	0.65, 2.21
Thyroid	3	1.18	0.24, 3.45	1.16	0.24, 3.38

[a] Shading indicates statistical significance. Complete results are listed in Appendix C.

Cancers with a substantially lower than expected SIR

Table 6-11 lists those cancers for which Air Force veterans have a substantially lower than expected incidence. The incidence of non-Hodgkin's lymphoma in Air Force veterans was significantly less than expected compared to the Australian population. Cancers rates that were more than 10% lower than expected were: mesothelioma, chronic lymphoid leukaemia and cancers of the larynx, liver, stomach, testis and unknown origin. However these results were based on very small numbers and were not statistically significant.

Table 6-11: Standardised Incidence Ratios (SIRs) which were substantially lower than expected: Air Force Vietnam veterans

Cancer [a]	Number of cancers	Scenario 1 (Unknowns Excluded)		Scenario 2 (Unknowns Included)	
		SIR	95% CI	SIR	95% CI
Larynx	7	0.84	0.34, 1.73	0.82	0.33, 1.69
Liver	1	0.22	0.01, 1.21	0.21	0.01, 1.18
Lymphoid leukaemia - chronic	4	0.87	0.24, 2.23	0.85	0.23, 2.17
Mesothelioma	1	0.24	0.01, 1.35	0.24	0.01, 1.32
Non-Hodgkin's Lymphoma	9	0.48	0.22, 0.91	0.47	0.21, 0.89
Stomach	10	0.71	0.34, 1.31	0.69	0.33, 1.27
Testis	3	0.78	0.16, 2.28	0.77	0.16, 2.25
Unknown origin	15	0.89	0.50, 1.47	0.87	0.49, 1.43

[a] Shading indicates statistical significance. Complete results are listed in Appendix C.

6.5.4 Summary of cancer incidence among Service branches

Figure 6-5 compares SIRs and 95% CIs between the Service branches for selected cancers. Army had the largest number of veterans among the Service branches and therefore analysis of this group has the greatest power to detect a significant difference and exhibits the narrowest CIs. The Navy cohort, and to a greater extent, Air Force are much smaller and the CIs are wider and less precise.

The pattern of cancer incidence varied between the Service branches (refer to Table C.5, Appendix C). All branches showed some cancers for which the incidence was significantly lower than expected. Veterans from all three Service branches had a lower than expected incidence of non-Hodgkin's lymphoma, although this was significant in Scenario 2 only for Navy veterans. Navy and Army veterans had a lower than expected incidence of multiple myeloma and thyroid cancer (statistically significant for Army veterans) whereas Army and Air Force veterans had a lower than expected incidence of mesothelioma and liver, stomach and testicular cancers, although this is based on very small numbers for Air Force veterans.

Navy veterans had the highest incidence of cancer overall (22-26% higher than expected). Army veterans had an 11-13% higher than expected cancer incidence, whereas, the cancer incidence for Air Force veterans was 6-8% non-significantly higher than expected. Veterans from all Service branches had a significantly higher than expected incidence of genitourinary cancers (primarily prostate cancer) and melanoma. Navy and Army veterans also had a higher than expected incidence of cancers of the lung and oral cavity, pharynx and larynx. Among Air Force veterans, the incidence for these cancers was no different than for the Australian population. Also, Army and Air Force veterans had a higher than expected incidence of Hodgkin's disease.

Veterans from each Service branch had a significantly higher than expected incidence of leukaemia but the type of leukaemia differed by service. Incidence of myeloid leukaemia (Scenario 1 only) was higher than expected for Navy veterans, among Army incidence of chronic lymphoid leukaemia was higher than expected and among Air Force acute lymphoid leukaemia incidence was higher than expected, but based on very small numbers.

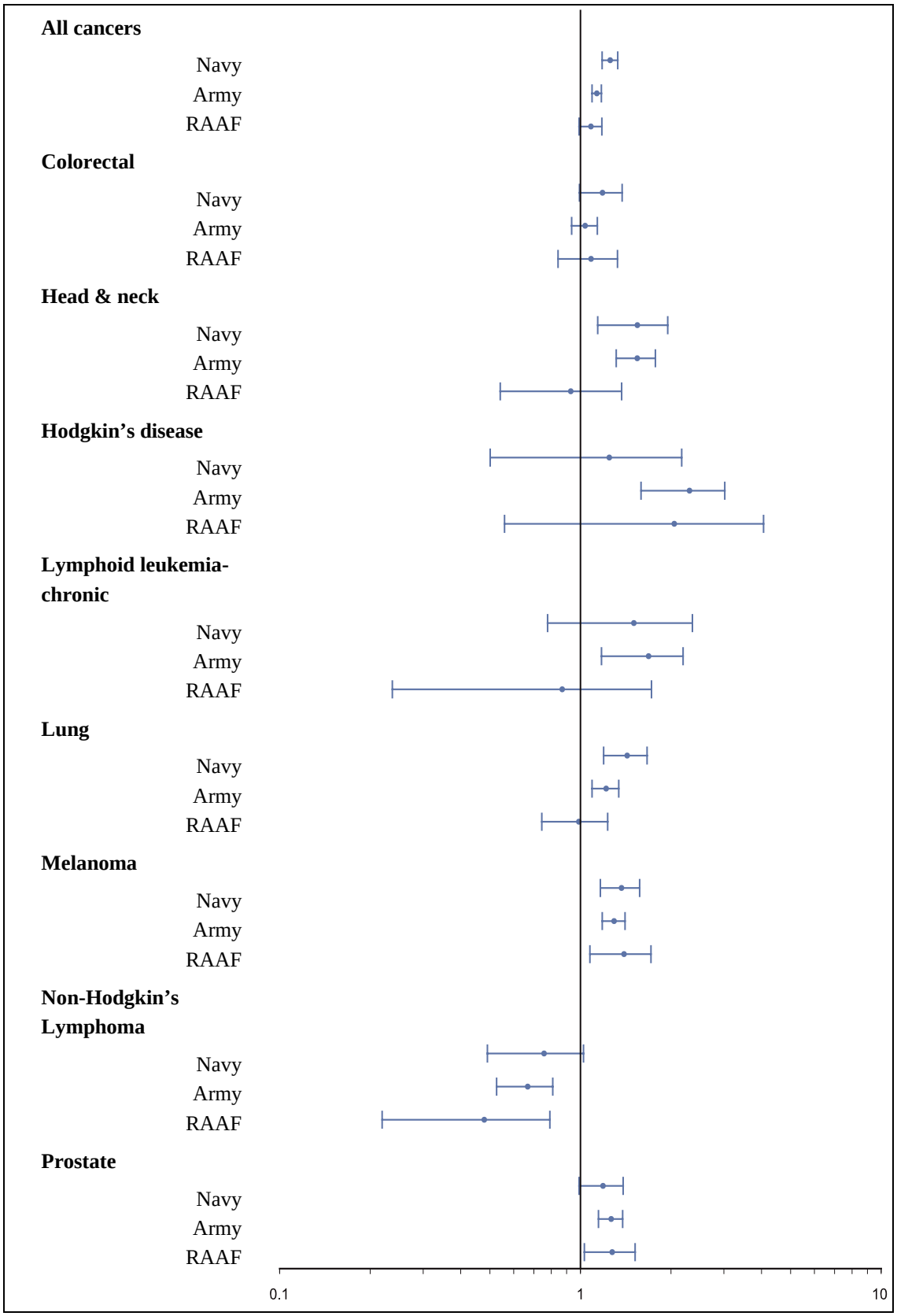


Figure 6-5: Comparison of Standardised Incidence Ratios (SIRs) and CIs by Service branch

6.6 Incidence of specific lung cancer histotypes

This study investigated the different histotypes of lung cancer to assess if the pattern of lung cancer among veterans differed from community norms.

The incidence of lung cancer among Navy and Army Vietnam veterans was higher than expected. Adenocarcinoma was the most common histotype of lung cancer, comprising 36.9% and 32.8% respectively. Table 6-12 lists SIRs for the main lung cancer histotypes by Service branch.

Table 6-12: Standardised Incidence Ratios (SIRs) for lung cancer histotypes by Service branch

Service branch and histotype [a]	Number of cancers	Scenario 1 (Unknowns Excluded)		Scenario 2 (Unknowns Included)	
		SIR	95% CI	SIR	95% CI
All veterans					
Lung	576	1.23	1.13, 1.33	1.20	1.10, 1.30
Adenocarcinoma	188	1.45	1.24, 1.66	1.41	1.21, 1.62
Squamous	152	1.19	1.00, 1.38	1.16	0.98, 1.35
Small cell	87	1.23	0.97, 1.49	1.20	0.95, 1.45
Large-cell	79	1.07	0.83, 1.31	1.04	0.81, 1.27
Other	70	1.06	0.81, 1.30	1.03	0.79, 1.27
Navy veterans					
Lung	141	1.43	1.19, 1.67	1.38	1.16, 1.61
Adenocarcinoma	52	1.88	1.37, 2.40	1.83	1.33, 2.32
Squamous	35	1.31	0.87, 1.74	1.26	0.84, 1.68
Small cell	15	1.00	0.56, 1.66	0.97	0.55, 1.61
Large-cell	23	1.48	0.88, 2.09	1.44	0.85, 2.02
Other	16	1.16	0.67, 1.89	1.13	0.64, 1.83
Army veterans					
Lung	372	1.22	1.09, 1.34	1.19	1.07, 1.31
Adenocarcinoma	122	1.43	1.18, 1.69	1.40	1.15, 1.65
Squamous	99	1.21	0.97, 1.44	1.18	0.95, 1.41
Small cell	61	1.32	0.99, 1.65	1.29	0.96, 1.61
Large-cell	46	0.94	0.67, 1.22	0.92	0.66, 1.19
Other	44	1.02	0.72, 1.32	0.99	0.70, 1.28
Air Force veterans					
Lung	63	0.99	0.74, 1.23	0.96	0.72, 1.20
Adenocarcinoma	14	0.83	0.45, 1.40	0.81	0.44, 1.36
Squamous	18	0.97	0.57, 1.53	0.94	0.56, 1.48
Small cell	11	1.15	0.58, 2.06	1.12	0.56, 2.01
Large-cell	10	1.05	0.50, 1.93	1.02	0.49, 1.88
Other	10	1.08	0.52, 1.98	1.04	050, 1.92

[a] Shading indicates statistical significance. Complete results are listed in Appendix C.

6.7 Cancer incidence and Service characteristics

Cancer incidence among selected subgroups of veterans was investigated to assess any association between cancer incidence and service characteristics

6.7.1 Cancer incidence among specific Army units

Cancer incidence was investigated among two specific Army units: Australian Army Training Team Vietnam and 32 Small Ship Squadron.

Australian Army Training Team Vietnam (AATTV)

The AATTV started Vietnam service in 1962 training the South Vietnamese Army. They frequently served in locations away from the main Army region of Phuoc Tuy Province.

There were 105 cancers diagnosed among the 536 AATTV veterans eligible for the study. The overall incidence for all cancers was 21-24% higher than expected. This was of borderline statistical significance and higher than the SIR for the total Army cohort. The size of this unit was relatively small and statistical power limited for this analysis. However, the incidence of cancer of the oral cavity, pharynx and larynx was significantly higher than expected (SIR = 2.51 (95% CI 1.29, 4.38)). However lung cancer was not elevated amongst this group. Complete results are given in Table C.6, Appendix C.

32 Small Ship Squadron

32 Small Ship Squadron was a ship-based Army unit. These ships spent a large proportion of time in estuarine water along the Vietnamese coast and rivers.

There were 40 cancers diagnosed among the 509 veterans of 32 Small Ship Squadron eligible for the study. The power to detect a statistically significant difference was extremely limited amongst this small group. The overall cancer incidence was 10-11% higher than expected and not statistically significant. Complete results are given in Table C.7, Appendix C.

6.7.2 Cancer incidence among specific Navy units

The protocol of the study proposed to explore the association of cancer incidence with aspects of Navy service in Vietnam. Calculation of SIRs for specific groups and development of regression models were employed to investigate two broad issues:

- the association of number of cancers diagnosed with service on specific ships or types of ships (ship-by-ship analysis or ship model), and
- the association of number of cancers diagnosed with time in Vietnamese waters (time in Vietnamese waters or water model).

To minimise confounding, analysis for the ship model was restricted to Navy personnel who served on one ship only (n = 9512, or 71% of the Navy cohort) and excludes those who served in in-country units.

SIRs for selected ship-by-ship analysis

SIRs were calculated to compare cancer incidence for crews of specific ships to the Australian male population. This analysis was limited to the larger groups only due to power considerations in the ability to detect a statistically significant result. SIRs were calculated for those who served on HMA Ships *Melbourne* only (n = 1,176), *Sydney* only (n = 3,472), and gunline ships only (HMA Ships *Brisbane*, *Hobart* and *Perth*, n = 1,039). The gunline voyage of HMAS *Vendetta* was not included in this analysis but was included in the regression analyses.

Those who served on HMA Ships *Melbourne* only or *Sydney* only had higher than expected cancer incidence for all cancers similar to the SIR for the all Navy cohort. The SIR for all cancers for the crews of the three main gunline ships was 9-11% non-significantly higher than expected. Table 6-13 lists those results for which the cancer incidence was statistically significantly different than expected. For those who served only on HMAS *Sydney*, the incidence of pancreatic cancer was lower than expected for Scenario 2 only, 0 observed and 4 expected. The incidence of colon cancer and head and neck cancer was higher than expected for those who served on HMAS *Melbourne* and the incidence of lung cancer was higher than expected for those who served on HMAS *Sydney*. None of the incidence ratios of the cancers analysed for the three gunline ships combined showed any statistically significant difference from the Australian population. Complete results are in Tables C.8 through C.10, Appendix C.

Table 6-13: Standardised Incidence Ratios (SIRs) which were significantly different than expected: selected ship crews

Ship Crew (N) and Cancer	Number of cancers	Scenario 1 (Unknowns Excluded)		Scenario 2 (Unknowns Included)	
		SIR	95% CI	SIR	95% CI
HMAS *Melbourne* (1,176)					
All cancers	141	1.23	1.03, 1.43	1.18	0.99, 1.38
Colon	19	1.87	1.12, 2.92	1.79	1.08, 2.80
Head and neck	10	2.14	1.03, 3.94	2.07	0.99, 3.81
HMAS *Sydney* (3,472)					
All cancers	241	1.20	1.04, 1.35	1.15	1.01, 1.30
Pancreas[a]	0	0.00	0.00, 1.01	0.00	0.00, 0.98
Lung	36	1.61	1.08, 2.14	1.55	1.05, 2.06
Gunline (1,039)					
All cancers[b]	74	1.11	0.86, 1.36	1.09	0.84, 1.33

[a] SIR is statistically significant for Scenario 2 only.
[b] Results are not statistically significant.

Ship model

This section presents the results of the investigation of the effect of service on specific ships or types of ships on cancer incidence. Of the 9,512 Navy veterans who served on one ship only, 196 died prior to the start of the study and 272 of unknown status were excluded from the analysis. Thus the ship model was based on 9,044 Navy personnel.

An internal Navy control group, those who served on HMAS *Melbourne*, was used for comparison. This ship was chosen because it had a relatively large cohort size and, although having Vietnam operational service, the ship did not serve close to the Vietnamese coast and thus would not have been exposed to any potential chemical contamination from that source.

The number of cancers diagnosed for crews on specific ships or types of ships is expressed as the relative risk for the ship crew of interest compared to the crew of HMAS *Melbourne*. Table 6-14 presents the results of the analysis. The results are presented as crude and adjusted relative risks. A crude relative risk compares the number of cancers diagnosed for the ship crew of interest to HMAS *Melbourne* only. The adjusted relative risk compares the number of cancers diagnosed for the ship crew of interest to HMAS *Melbourne* while controlling for age of the crew and the number of voyages made. The crew of HMAS *Melbourne* was substantially older than the other ships serving in Vietnam. The mean age at the start of the study (1982) for the crew of HMAS *Melbourne* was 41 years compared to the gunline and logistic/escort ship crews' age of 36 years.

The results of the analysis show that when controlling for the age of the crew and number of voyages made, there was no significant difference in number of cancers diagnosed among crews of specific ships or types of ships compared to the crew of the internal Navy control, HMAS *Melbourne*.

Table 6-14: Results of ship model analysis investigating cancer incidence for Navy veterans who served on one ship only

Comparison	Number in each group	Cancers	Person Years	Crude RR (95% CI) p value	Adjusted RR [a] (95% CI) p value
HMAS *Melbourne*	1,176	142	21,144	Reference group	Reference group
HMAS *Sydney*	3,471	245	63,752	0.57 (0.46, 0.71) p < 0.001	1.03 (0.81, 1.31) p = 0.796
HMAS *Perth*	370	19	6,845	0.41 (0.25, 0.68) p < 0.001	0.73 (0.44, 1.21) p = 0.220
HMAS *Hobart*	416	34	7,660	0.66 (0.44, 0.99) p = 0.044	1.09 (0.71, 1.66) p = 0.695
HMAS *Brisbane*	253	21	4,701	0.67 (0.42, 1.06) p = 0.086	1.39 (0.84, 2.28) p = 0.195
Gunline [b]	1,147	80	21,197	0.56 (0.44, 0.72) p < 0.001	1.00 (0.76, 1.32) p = 0.993
HMAS *Vampire*	596	53	10,810	0.73 (0.53, 1.01) p = 0.057	1.11 (0.80, 1.53) p = 0.530
HMAS *Vendetta*	464	28	8,464	0.49 (0.33, 0.74) p < 0.001	0.84 (0.56, 1.26) p = 0.391
HMAS *Duchess*	554	45	10,320	0.65 (0.46, 0.92) p = 0.015	1.14 (0.79, 1.64) p = 0.472
HMAS *Yarra*	383	30	7,103	0.63 (0.40, 0.99) p = 0.047	1.01 (0.64, 1.60) p = 0.961
Logistic/escort ships [c]	6,539	491	120,105	0.61 (0.56, 0.66) p < 0.001	1.06 (0.98, 1.14) p = 0.119
All ships [d]	7,868	594	144,619	0.61 (0.56, 0.66) p < 0.001	1.04 (0.96, 1.12) p = 0.321

Analysis was for Navy personnel who served in one unit only and excludes in-country units (n = 9512). 468 observations were not included in analysis due to unknown vital status (n = 272) or having died prior to the study period (n = 196). Ship-by-ship analysis for those who served in one unit only based on 9,044 Navy personnel.
Analysis calculates the relative risk of cancer compared to the internal Navy control, those who served on HMAS *Melbourne*.

[a] Adjusted for age at start of study, age-squared, and total number of voyages.
[b] Includes HMA Ships *Brisbane, Perth and Hobart* and the one gunline voyage of HMAS *Vendetta*. Analysis was controlled for clustering by ship
[c] Includes HMA Ships *Anzac, Derwent, Duchess, Parramatta, Queenborough, Quiberon, Stuart, Swan, Sydney, Torrens, Vampire, Yarra* and the logistic/escort voyages of *Vendetta*. Analysis was controlled for clustering by ship
[d] HMAS *Melbourne* compared to all other ship crews, excludes in-country units, and clustered by ship.

6.7.3 Effect of time in Vietnamese waters

As described in Chapter 3, work done on the Study Roll determined the time each Navy veteran spent on board ship in the Vietnamese operational area. The effect of time on board Navy ships in Vietnamese waters was investigated using two methods: calculation of SIRs and development of a regression model.

SIRs by time in Vietnamese waters

SIRs for Navy veterans who served less than or equal to 30 days in Vietnamese waters and those who served more than 30 days are listed in Tables C.11 and C.12, Appendix C. There were 845 cancers diagnosed among 10,121 veterans in the former group and 228 cancers diagnosed among 2,814 veterans in the later group. The cancer incidence for all cancers was 21-26% higher than expected in both groups and did not vary with time spent in Vietnamese waters.

Vietnamese water model

The association between number of cancers diagnosed and days spent in Vietnamese waters was assessed using a regression model. As discussed in Chapter 4, a matrix of days in Vietnamese waters by ship type was constructed for each Navy veteran. For every Navy veteran the total number of days in Vietnamese waters was categorised by number of days on gunline service, number of days on logistic/escort service, number of days on HMAS *Melbourne* service, and number of days on cargo ship service. Thus, all days served within the Vietnamese waters operational area have been allocated by the type of ship served. The distribution of this service is detailed in Table 6-15.

Table 6-15: Days in Vietnamese waters by type of service: Navy Vietnam veterans

Group	Number [a] (%)	Mean VW days ± SD	Median VW days	Range	75th %'tile	90th %'tile
Logistic/escort	10,451 (77.2)	4.8 ± 3.9	4	1 - 66	7	10
Gunline	2,622 (19.4)	122.1 ± 44.2	101	4 - 343	115	206
Melbourne	2,139 (15.8)	1.8 ± 0.7	2	1 - 3	2	3
Cargo	180 (1.3)	23.0 ± 17.3	19	4 - 94	33	48

[a] Navy personnel may have served in more than one group or have served in multiple units within a group.

This analysis includes all Navy veterans who were alive at the start of the study and did not serve in land based in-country units. There were 1,046 cancers diagnosed among the 12,655 Navy veterans eligible for this analysis. Table 6-16 details the number of veterans in each of the groups. These groups were not mutually exclusive. However the regression analysis was based on individual veterans' entries and the numbers of cancers and person-years contributed to the analysis are not double counted.

Table 6-16: Number of cancers and person-years by type of Navy service

Group [a]	Number	Number of cancers	Number of person-years
Logistic/escort	9,925	784	182,277
Gunline	2,525	188	46,741
Melbourne	1,953	221	35,300
Cargo	170	19	3,027

[a] Groups are not mutually exclusive.

The model controlled for age at the start of the study, total number of voyages and total number of ships on which the veteran served. Table 6-17 gives the results of the regression analysis. As explained in Section 4.8.2, the results for the water model are given as the β-coefficient in the regression equation for the days in Vietnamese waters by ship type variables. If the 95% CI for the β-coefficient excludes zero, this indicates a statistically significant association. Although there was a small positive dose response for the number of days in Vietnamese waters serving on cargo ships, overall this model did not demonstrate any association with time in Vietnamese waters and cancer incidence.

Table 6-17: Effect of days in Vietnamese waters on cancer incidence by type of service

Model [a]	Coefficient	95% CI	P value	Lr Test [b]
HMAS *Melbourne* days	0.062	-0.039, 0.164	0.231	
Gunline days	-0.0001	-0.002, 0.001	0.855	$Chi^2 = 5.68$
Logistic/escort days	0.027	-0.002, 0.056	0.072	P = 0.224
Cargo days	0.016	0.001, 0.021	0.034	

[a] Model was controlled for: age at start of study, age squared, total number of voyages and total number of units served. Outcome was number of cancers diagnosed.
[b] Result of maximum likelihood test comparing full model to model without the four water days-by type of ship variables. Chi^2 with 4 degrees of freedom.

6.8 Summary

The results presented in this chapter show that Australian Vietnam veterans have a 13-15% significantly higher than expected cancer incidence overall. The four most common cancers in these veterans were melanoma, prostate, colon and rectum, and lung cancers and comprise 58% of all cancers diagnosed. There was an excess of 613 cancers; 88% of this excess consisted of lung cancers, oral cavity, pharynx and larynx cancers, prostate cancers and melanomas.

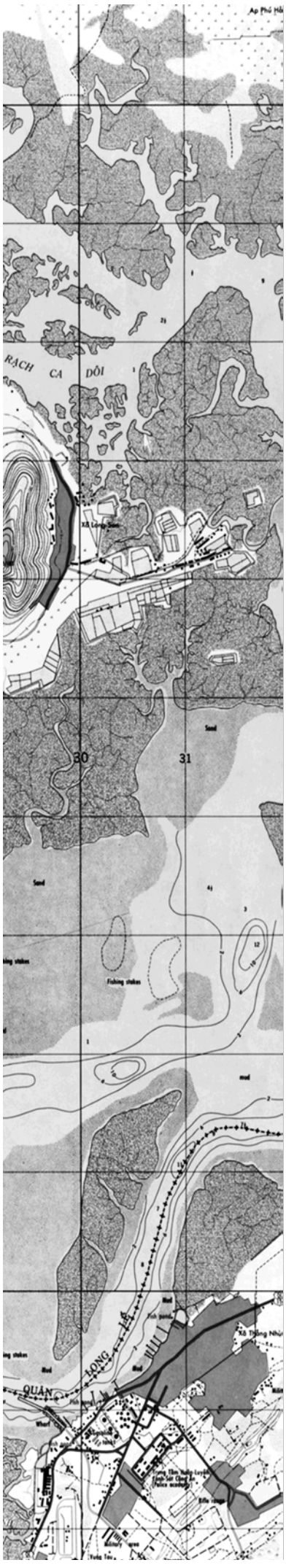
Cancer incidence rates for those cancers of *a priori* interest showed a mixed pattern. Of the 16 cancers of *a priori* interest, the rates of five (cancers of the head and neck, lung, prostate, Hodgkin's disease and melanoma) were significantly higher than expected. The rates of four cancers (liver, thyroid, multiple myeloma and non-Hodgkin's lymphoma) showed a significantly lower than expected incidence. The incidence of all other cancers of *a priori* interest was not significantly different from the Australian population.

The pattern of cancer incidence varies between the Service branches. Navy veterans had the highest incidence of cancer, higher than expected by 22-26%, followed by Army veterans, higher than expected by 11-13% whereas Air Force veterans had a 6-8% non-significantly higher than expected rate of cancer. Veterans from all Service branches had a higher than expected incidence of genitourinary cancers, primarily prostate cancer, and melanoma. Navy and Army veterans also showed a higher than expected incidence of cancers of the lung and head and neck region. Whereas Navy veterans also demonstrated a higher than expected incidence of gastrointestinal cancer, Army and Air Force veterans showed higher than expected incidence of Hodgkin's disease and prostate cancer.

Veterans from all three Service branches had a lower than expected incidence of non-Hodgkin's lymphoma, although this was significant in Scenario 2 only for Navy veterans. Navy and Army veterans had a lower than expected incidence of multiple myeloma and thyroid cancer whereas Army and Air Force veterans had a lower than expected incidence of mesothelioma and liver, stomach and testicular cancers.

Cancer incidence among Navy personnel was investigated further. Within the limitations of the service details available for Navy personnel, the higher than expected cancer incidence among this group could not be attributed to either the ship on which they served nor the time spent in Vietnamese waters.

Chapter 7 discusses the results presented in this chapter in the context of community norms and the scientific literature.



7

Discussion and conclusions

Chapter 7 Discussion and conclusions

7.1 Consideration of study design

7.1.1 Study groups

This study examined cancer incidence from 1982 to 2000 among the cohort of Australian male Army, Navy and Air Force veterans who served in Vietnam between May 1962 and July 1973. The follow-up period therefore starts a minimum of nine years after the service ended (for those who served in 1973) and continues up to 38 years post-service for the veterans who served early in the Vietnam War. Only males were included because the number of Australian females who served in Vietnam was very small. It would therefore be difficult to study this group in a way that gave meaningful results or did not compromise the privacy of individuals concerned.

The study covered all cancer sites except non-melanocytic skin cancers. As these are not generally registrable diseases in Australia, the cancer registries and national cancer incidence data contain little information on non-melanocytic skin cancer.

7.1.2 Strengths and weaknesses of the study

This study has many strengths, including its size, data quality, high percentage of known vital status and the homogeneity of the study population.

Firstly, the study is large. The number of individuals in the study is over 59,000. When combined with the period of observation, the resulting person-years of observation are just over one million. This gives the study considerable power. For example, power calculation indicates that the study would have greater than 80% chance of detecting a 30% elevation in cancer with an incident rate of about nine per 100,000 individuals per year at the 95% significance level. In a cohort of this age, this would mean that there would be a strong probability of detecting an elevation in the rate of a cancer as rare as cancer of the pancreas.

Secondly, the quality of the data used in this study is good. The cancer incidence data were obtained from the National Cancer Statistics Clearing House. Cancer is a notifiable disease in all States and Territories, and as discussed in Chapter 4, the completeness of the data is high.

Thirdly, the vital status of 97.5% of the veteran cohort was ascertained and, although about 2.5% of the study population was lost to follow up, sensitivity analyses revealed that the results obtained were robust. This was assessed by

firstly including the person-time for those veterans whose vital status could not be ascertained, thereby underestimating the rate of cancer. The next stage involved excluding person-time for those whose vital status could not be ascertained, thereby overestimating the rate of cancer. In nearly all cases, the study found that if a cancer had a significantly elevated or reduced SIR this was seen regardless of whether those lost to follow up were included or excluded.

Fourthly, the population was also relatively homogeneous, with all the population being male, nearly all Caucasians, and through the military selection process, having to meet certain literacy and educational standards and pass a medical examination.

A potential weakness is that some men may have changed their names, or may have enlisted under a different name or date of birth. This would have impeded the study's ability to find these men or identify their cancers. As it is uncommon in Australia for men to change their name, the number in the study contributing to this weakness would be small.

Another feature of this study was that it used probabilistic matching to ascertain cancers. This has the advantage that it can detect those cancers not detected by exact matching, for example due to slight differences in spelling of names. Conversely, a cancer could be attributed to someone in the study when it actually occurred in someone else with a similar name or date of birth. This could lead to a lower specificity of matching. While all cancers are used to construct the Australian community data to which the veterans are compared, the rate in the veteran population is calculated on those cancers ascertained by probabilistic matching.

Thus, while the study should have identified the vast majority of cancers that have developed in male Australian Vietnam veterans in the years under observation, some may have been missed. This would have the effect of underestimating the rate of cancer in the study populations. Alternatively, others may have been incorrectly matched, creating a small level of uncertainty about the results.

7.1.3 Potential biases and confounders

Healthy worker effect

Described briefly, the healthy worker effect is a result of the fact that those in a community who are in paid work are generally healthier than the community as a whole, which by definition includes those who are too sick to work. Military populations also have some degree of health screening in many countries and may also have privileged access to health care.

Among studies of veteran populations, the healthy worker effect can be pronounced. For example, Rothberg *et al* found that the United States' army had a mortality rate that was only one half that of the general population[1]. Studies of former members of the armed forces have also shown that the healthy worker effect can persist for long periods. For example, Darby *et al* [2] in their study of British participants in nuclear testing in Australia found that their

mortality rate was still below that of the general community some thirty years after they entered the cohort.

Some researchers maintain that the healthy worker effect is not evident in cancer rates[3]. However, studies of veterans have suggested that there is a generally lower rate of cancer for several decades after selection[2]. This can occur because the existence of a malignancy would generally exclude one from military service. Those who have had one cancer are more likely to have another. Further, there is a range of conditions, such as ulcerative colitis and chronic lung disease that are established risk factors for the development of cancer, but may also act to prevent the individual from being able to enter military service.

Selection bias within the military

The healthy worker effect can be exaggerated for military veterans because they are actively screened for health problems at selection into the military and before they are deployed. This means that military personnel who are considered fit to be deployed are free of a number of conditions that affect people who are apparently healthy and would be considered fit to work in other contexts (sometimes called the healthy soldier or warrior effect).

Conditions that may lead to a person not being deployed include suffering from acute and self-limiting conditions, such as fractures and strains, but also those who are suffering from diseases that include the early stages of cancer, or from diseases that may later predispose to cancer. Thus, those deployed are likely to be the subject of a selection bias. This bias should act to give a rate of cancer incidence lower among the deployed group although it may be that the effect would decrease with time.

Potential confounding effects

The analysis of cancer incidence in this study is not able to take into account confounding effects on which there is no information. Information about tobacco smoking is not available for the veterans thus it is not possible to control for this major confounder in the analyses. However, an argument can be raised that combat veterans, who are given cheap or free cigarettes at a time of stress, may be more likely to take up smoking as a result of this service. If this was accepted, then smoking might be seen as an intermediate on the causal pathway between service in Vietnam and cancer and should therefore not be controlled for in analyses.

7.2 Discussion of cancers of *a priori* interest

Several cancers were identified at the beginning of this study as being of *a priori* interest. The list was designed to be inclusive, and there are perhaps some cancers on the list of diseases of *a priori* interest that would not be included today except that they were nominated in previous studies.

Data discussed below refer to the cancer incidence in all the Services combined, unless otherwise stated.

Role of chance

There is a possibility (about one in 20) that a cancer that appears to be elevated at the 5% significance level in the veteran population is really no different from its incidence amongst the rest of the population. This possibility increases as more cancers are examined. In this study we have tried to guard against this possibility of misinterpreting such results by considering the findings in the light of past research and discussing whether there is a plausible biological mechanism for elevated cancers in the veteran population.

7.2.1 All cancers

Overall, there was an elevation in the incidence of cancer in this population of Vietnam veterans. This elevation was found in all branches of the armed forces, although in Air Force (which had much smaller numbers) this was of borderline statistical significance, and the change in the SIR was more modest than in other groups.

Although 'all cancers' is a group of heterogeneous tumours with a variety of causes, it is often the case that populations with exposure to carcinogenic agents show elevation in the overall cancer rate.

7.2.2 Melanoma

The study observed 762 cases of melanoma. This rate of melanoma was elevated, and this elevation was significant ($p < 0.001$, $p < 0.001$ and $p < 0.01$) among Army, Navy and Air Force personnel. The SIR showed some consistency, being 1.30, 1.38 and 1.40 across the three branches of Service.

In this population of Australian Vietnam veterans, a significant elevation in the validated life-time prevalence of melanoma has been reported[4], although a much earlier study had revealed a non-significant increase in the rate of melanoma[5].

A recent study of the cancer incidence in US veterans found a significant elevation in melanoma among Ranch Hand veterans; a non-significant elevation was also found in a comparison group that served in South East Asia at the time of the Vietnam War[6]. Previous studies of this group have also revealed a borderline elevation in mortality from melanoma[7].

The aetiology of this tumour is becoming well understood, with the most important cause being exposure to ultraviolet radiation.

7.2.3 Prostate cancer

Prostate cancer was identified as being of *a priori* interest because, first, there is suggestive evidence that it is associated with herbicide exposure and, secondly,

this population was shown to have higher than expected mortality from this disease in a previous study.

We observed 692 cases of prostate cancer, this being the largest number for any single ICD code (except melanoma). This represented a significant ($p < 0.001$) elevation (25%) above the rate expected amongst the community. In contrast to some other cancers, this was found to be elevated across all three branches of Service.

An elevation in prostate cancer rate has been observed in a recent study of US Air Force Vietnam Veterans[6]. In this study, both the Ranch Hand group and comparison group that served in South East Asia at the time of the Vietnam War showed significant elevations in the incidence of prostate cancer over the general community.

There are alternative explanations (beyond herbicide exposure) that may be constructed for this elevation in prostate cancer. Prostate cancer may be more likely to be detected in Vietnam veterans because they are more likely to request screening for cancer, and have their blood tested for Prostatic Specific Antigen (PSA). This could occur as a result of higher levels of anxiety about health generally, as a result of the Agent Orange controversy. Alternatively it could be argued that because the health of military personnel is routinely checked during their years of service, veterans are subsequently more likely to seek health services and screening than their counterparts in the general population.

The role of sexual activity and sexually transmitted diseases in prostate cancer aetiology has also been the subject of epidemiological research. For example, Dennis *et al* found an association between previous infection and later development of prostate cancer[10] and a study by Rosenblatt *et al* showed similar risk after an infection[11]. More recently, Dennis and Dawson have undertaken a meta-analysis of measures of sexual activity[12]. Their work indicates an association between prostate cancer and sexually transmitted infections. Such infections occurred among Australians in Vietnam[13] with Hart reporting that about 18% of a sample of 376 soldiers interviewed after serving 12 months in Vietnam had acquired a venereal disease[14]. Perhaps this could contribute to the higher rates of prostate cancer.

A diet high in fat has been associated with a higher rate of prostate cancer[15]. However, it is doubtful that the Vietnam veteran population as a group ate more fat than the general population.

Interestingly, a recent study of cancer incidence and mortality of Australia's veterans of the Korean War found that they were also at greater risk of prostate cancer and death from prostate cancer[16].

7.2.4 Lung Cancer

Lung cancer was identified as being of *a priori* interest for several reasons:

- it has been associated with herbicide exposure, as noted by several reviews of the literature by the National Academy of Sciences;
- rates were elevated in previous studies of Australian Vietnam veterans; and
- it is strongly associated with cigarette smoking.

In addition, this population may have had exposure to asbestos and diesel fumes, both of which contribute to elevated risk for this particular disease.

The study identified 576 cases of lung cancer. This represents a significant ($p < 0.001$) elevation above the number that would be expected, with the rate about 25% higher than expected. The significant elevation was found in both Army and Navy veterans, although not Air Force veterans whose rate was close to that in the general population.

The elevation in incidence was consistent with the findings of a previous mortality study of this cohort, where an SMR of 1.23 (95% 1.123 1.33) was noted[7].

There are several possible explanations for this elevation in Australian Vietnam veterans. It is possible that there may be errors in diagnosis, with cancers of other primary sites that have metastasised to the lung, but again this would not appear to be a likely explanation for more than a small number of cancers and any misclassification would pertain to the general population as well. It would seem that elevation in cigarette smoking might explain at least part of the increase in lung cancer. It is also possible that exposure to herbicides, asbestos and diesel fumes may have made a contribution to the increased risk of lung cancer. These exposures are hard to quantify, and it is therefore difficult to be certain what contribution if any these may have made to the increased rate of lung cancer.

There were sufficient numbers of lung cancer to analyse the rate by histological type. Lung cancer was divided into five histological types – squamous cell carcinoma, adenocarcinoma, small-cell carcinoma, large-cell carcinoma and other types. The greatest elevation was in the rate for adenocarcinoma. A search of the literature did not reveal which histological type of lung cancer is associated with exposure to herbicides and dioxins. The findings from this study suggest that this might be a useful area of investigation.

7.2.5 Cancer of the Head and Neck

This is a group of cancers that includes the gum, mouth, tongue and pharynx. This group of cancers is believed to have similar aetiological factors.

In this study, 247 cases were observed as compared to an expected 167. This represents a 50% increase and is statistically significant ($p < 0.001$).

This group of cancers was found to be elevated in a previous mortality study of this cohort[7] and is associated with cigarette smoking and alcohol drinking. There is a synergistic effect between these two carcinogenic agents.

7.2.6 Non-Hodgkin's Lymphoma

This malignancy was considered to be of *a priori* interest because it has been associated with exposure to herbicides. Also a previous study had reported an elevation in this type of tumour in Vietnam veterans[4].

In this study, the rate of Non-Hodgkin's lymphoma (NHL) was found to be significantly ($p < 0.001$) decreased (126 observed compared with an expected number of 189), with the rate being about two-thirds of the Australian rate.

One possible explanation for this result is that there could be a classification bias. The two malignancies that are most likely to be confused with NHL are Hodgkin's Disease and Chronic Lymphoid Leukaemia, and both of these have elevated rates amongst Australian Vietnam veterans. Thus, it may be that a number of true cases of NHL were mistakenly classified as either Hodgkin's Disease, or Chronic Lymphoid Leukaemia or both. However systematic errors in classification seem unlikely because many pathologists made these diagnoses all over Australia and over a long period of time.

A more subtle explanation is that those at risk of NHL have been selectively removed from the population at risk by developing Hodgkin's Disease and Chronic Lymphoid Leukaemia which were both elevated in the Vietnam veterans.

This study could not make observations prior to 1982. If there were an early elevation in NHL rates which did not persist over time then this would not have been detected in this study. This issue will be further explored in the mortality study, the next to be reported in this four-study series.

7.2.7 Hodgkin's Disease

The rate of Hodgkin's disease was found to be elevated ($p < 0.001$) in this population, with a rate about double that expected, based on observing 51 cases compared to an expected number of 25. This cancer was of *a priori* interest because of the possible relationship to herbicide exposure, particularly the contaminant 2,3,7,8-tetracholorobenzo-*p*-dioxin. The elevation in rate was found to be present across all branches of the military, although in Air Force and Navy veterans, with much smaller numbers, the confidence limits were wide and included unity. In the Army, based on 40 observed cases, the rate was about double that found in the general Australian population.

This elevation in Hodgkin's Disease is difficult to explain. As noted above, it could be a consequence of misclassifying NHL, as the histological diagnosis of Hodgkin's Disease can be at times difficult. Another possibility is that this increase is a result of herbicide exposure, which is discussed more fully in Section 7.5.1.

7.2.8 Liver Cancer

There was a decrease in hepatocellular carcinoma in the overall cohort, particularly amongst Army and Air Force veterans.

Primary liver cancer is relatively rare in Western societies, particularly when compared to the rate of this tumour found in Asian and African communities. This is due to certain endemic viral infections of the liver in these communities which make them particularly prone to the development of hepatocellular carcinoma.

It is interesting to note that service in an area where hepatocellular cancer is far more common did not place Australian Vietnam veterans at greater risk for this disease. In addition, although this tumour is associated with excess alcohol consumption, there was a decrease in risk.

7.2.9 Thyroid Cancer

Overall, the rate of thyroid cancer found in this population did not differ from that found in the general population.

This tumour was listed as being of *a priori* interest because of early reports of a possible association with herbicide exposure. Later studies have not confirmed this association, and it is not among those cancers that the National Academy of Sciences has found to be associated with herbicide exposure[18].

7.2.10 Multiple Myeloma

In contrast to the rate of Hodgkin's Disease, the rate of multiple myeloma was found to be significantly decreased ($p = 0.009$). This decrease was not found to be consistent across all branches of Service; the rate in Air Force was close to that expected.

7.2.11 Soft-tissue Sarcoma

Soft-tissue sarcoma is another tumour that has been classically associated with exposure to phenoxy herbicides[18]. It is a relatively rare tumour, with heterogenous histological groups.

In this study, the rate of soft-tissue sarcoma did not differ from expectation. This observation was made consistently across all three branches of the Service, although Air Force veterans had low numbers of expected tumours and no cases actually observed.

7.2.12 Leukaemia

The overall rate of leukaemia was higher than expected but this was of borderline statistical significance for the 130 cases diagnosed. Specific types of leukaemia are discussed in Section 7.3.

7.2.13 Brain Cancer

Brain cancer was listed as being of *a priori* interest because a cancer incidence study published in 1992 reported an elevation in brain cancer relative risk in a sub-population of Australian Army veterans[5].

However, in the present cancer incidence study, the rate of brain cancer was very close to expectation in the overall group of veterans, and in each of the individual Services of the military populations. A review of the more recent literature would suggest that this finding would be expected, and that there is little reason to expect that the rates for this tumour would differ from expectation. The National Academy of Science review now lists this as one of the tumours for which there is evidence of no association with herbicide exposure[18].

7.2.14 Other cancers of *a priori* interest

The incidence rate of bladder, breast and testicular cancer did not differ from the rate that would be expected in the Australian population. Similarly the incidence rate for the combined group of all gastrointestinal cancers was not significantly different from expectation. Specific types of cancer within this group are discussed in the following section.

7.3 Discussion of specific cancers other than those of *a priori* interest

The incidence of a number of other specific cancers was investigated in the veteran population and discussed in this section.

7.3.1 Colon, Rectum and Colorectal Cancer

The rate of colon cancer showed a small increase, which was statistically significant in Scenario 1 only. The rate of cancer of the rectum and the combined group of colorectal cancer is based on large numbers (622 for colorectal cancer) and of borderline significance ($p = 0.08$). However, the rate colorectal cancer is so close to unity (SIR = 1.07, (95% CI 0.99, 1.16)) that it is difficult to interpret this small elevation of colon cancer as one of significant clinical importance.

7.3.2 Chronic Lymphoid Leukaemia

Recently, the National Academy of Science published a review reclassifying chronic lymphoid leukemia from the category of inadequate or insufficient evidence of association to the category of sufficient evidence of association with dioxin exposure[18].

The present study finds that the overall rate of lymphoid leukaemia was elevated but this was a consequence of the elevation in the incidence of chronic lymphoid leukaemia. Based on 58 observed cases (compared to 37 expected), the rate of

this type of tumour was about 50% above expectation ($p < 0.01$). The effect appeared consistent across Army and Navy; it did not manifest among Air Force veterans although the number of cases of this leukaemia in the Air Force were particularly small.

7.3.3 Other forms of Leukaemia

There was some variation in the incidence of other forms of leukaemia among the Service branches. The rate of myeloid leukaemia was elevated by more than 60% among Navy veterans but this was statistically significant in one scenario only. Among Air Force veterans, there was a significant elevation in the rate of acute lymphocytic leukaemia. The overall rate of other forms of leukemia among the cohort did not differ from the rate that would be expected in the Australian population.

7.3.4 Eye Cancer

An elevation in the rate of cancer of the eye was detected in Army veterans with 21 cases observed against 11 cases expected, giving a significant SIR of 1.99. While Navy veterans showed no evidence of an elevation, Air Force veterans had a similar SIR to Army, based on four cases against an expected two; the small size of this cohort meant, however, that the confidence intervals were wide.

Among Army veterans, a previous mortality study had found an elevation in mortality from eye cancer for this group, with three observed deaths against an expected 0.5, giving SMR of 6.18 (95%CI 1.27, 18.06) [7].

Histologically, the majority of these tumours were melanomas, which is consistent with the general population. It is possible that the same factor that increased the level of melanoma of the skin may have contributed to an increase in eye melanoma risk, with an increase in UV exposure a likely cause.

7.3.5 Mesothelioma

The rate of mesothelioma did not significantly differ from the rate that would be expected in the Australian population, although in Navy veterans the SIR was elevated at 1.70 (95% CI 0.88, 2.96). This result suggests that the level of asbestos exposure was not sufficient to result in an elevation of mesothelioma, particularly in Army and Air Force veterans. Alternatively, perhaps mesotheliomas are still to develop in the future, as the disease has a long latent period. It might be prudent to re-evaluate this for Navy veterans at some point in the future.

7.3.6 Other Cancers

The rate of kidney, oesophageal, pancreatic and stomach cancer, and carcinoma of unknown primary did not differ from the rate that would be expected in the Australian population.

7.4 Variations in cancer experience by branch of Service

7.4.1 Navy Vietnam veterans

As discussed in previous chapters, the involvement of the Royal Australian Navy in Vietnam was complex. Members of the Navy could have had land-based service or service on gunline, logistic/escort or cargo ships or any combination of these different types of service.

Thus, there are a wide variety of experiences contained within the Australian Naval involvement in the Vietnam War, and each of these experiences could have resulted in a different cancer experience. An unexpected and counter-intuitive finding of the previous mortality study was that Navy veterans had a significantly elevated rate of death compared to Army and Air Force veterans[7]. A subsequent laboratory model suggested that it might have been possible for contamination of potable water with dioxin to occur via the evaporative distillation units used on Australian ships[17]. In the present study, cancer rate among Navy veterans was higher than in the other Service branches.

The cancer rate was further evaluated by deployment based on specific ship or ship type and time spent in Vietnamese waters. Calculation of SIRs for various subgroups of Navy personnel was limited to the larger groups due to power considerations. In addition, several regression analyses were performed, investigating the possible association of cancer incidence with the ship or type of ship on which the veteran served and days spent in Vietnamese waters. Within the limitations of the Navy service data, there does not seem to be any demonstrable association between ships or type of ship served, time in Vietnamese water and cancer incidence. This study did not, therefore, provide any evidence to support the hypothesis that the increased cancer rates seen among Navy personnel could be attributable to exposure to contaminated water.

7.4.2 Army Vietnam veterans

The Army was the Service with the largest number of personnel in Vietnam.

Two subgroups within the Australian Army were investigated. One group, known as the Australian Army Training Team Vietnam (usually known as ‘the Team’) worked with the Army of the Republic of Vietnam (ARVN). Although the name suggests it was a training force, in practice members of the Team were heavily involved in combat alongside the ARVN units with which they worked. Members of the Team served all over South Vietnam.

Another smaller group was the 32 Small Ship Squadron. This was a group that, within the structure of the Australian forces at that time, was considered part of the Army but was actually a ship based unit that served in the river and estuarine waters of Vietnam. It seemed reasonable to suppose that the exposures of these two groups may have been sufficiently different to create a differing cancer pattern.

The cancer analysis of these sub-groups of Army was not, at this stage, useful. Although there were suggestions of emerging differences, such as the AATTV having a slightly higher cancer incidence than Army, in general the numbers were too small for meaningful comparisons to be made.

7.4.3 Air Force Vietnam veterans

Air Force had the smallest number of personnel of the three Services that served in Vietnam. Thus, the confidence intervals are wider for this group.

There was an elevation in the rate of all cancer that was of borderline statistical significance, whether the unknowns were included or excluded.

In general, very few cancers among Air Force veterans had a rate that differed significantly from the community norm – the exception being melanoma and the broad category of genitourinary cancer, which was driven by an elevation of borderline significance in prostate cancer. This elevation was also seen in the other two branches of Service. The lack of a significant elevation for other cancer types needs to be interpreted with caution. This may simply reflect the smaller size of the Air Force cohort.

The majority of Air Force veterans served at a different location to the Army and Navy veterans. Perhaps their environmental exposures were different. It is also possible that the Air Force veterans had different changes in lifestyle during and after Vietnam service compared to Army or Navy veterans.

7.5 Factors influencing cancer incidence

The aim of the study was to document cancer incidence. The study has limited ability to explore any association between cancer incidence and possible exposures and effects that occurred during service in Vietnam, with the exception of the anti-malarial drugs such as dapsone, that is the subject of a separate report yet to be finalised.

The lack of exposure data has implications for observations that can be made on cancer incidence. For any theoretical exposure to a carcinogen, it is likely that the exposure would have varied amongst the group under study. This means that examining the effect in the overall population would obscure the effect in the exposed sub-group.

Although quantification of specific exposures is beyond the scope of this study, a number of possible exposures have been identified and are described below.

7.5.1 Possible occupational and environmental exposures

There are a variety of possible occupational and environmental exposures that could have contributed to the different pattern of cancer incidence observed among Vietnam veterans.

Pesticides and Herbicides

One possible explanation for cancer rates to differ from expectation was exposure to herbicides used in Vietnam. A recent authoritative and comprehensive review of the literature undertaken by the National Academy of Science found that there are four cancers with 'sufficient evidence' of an association with herbicides[18]. The incidence for two of these cancers, chronic lymphoid leukaemia and Hodgkin's disease, was significantly elevated in the present study, whereas one was significantly decreased, and one was not different from the community expectation (Table 7-1). Rates of three of four cancers considered by the review as having 'limited evidence' for an association with herbicide exposure was, however, significantly elevated. Thus, although herbicide exposure may have contributed to the increase in cancer rates, the pattern does not seem to be consistent.

Table 7-1: Herbicide related cancers in Australian Vietnam veterans

Disease	NAS Category	Result in this study
Chronic Lymphoid Leukaemia	Sufficient	significantly elevated
Soft Tissue Sarcoma	Sufficient	does not differ from expectation
Non Hodgkin's Lymphoma	Sufficient	significantly decreased
Hodgkin's Disease	Sufficient	significantly elevated
Lung Cancer	Limited	significantly elevated
Prostate Cancer	Limited	significantly elevated
Multiple Myeloma	Limited	significantly decreased
Larynx Cancer	Limited	significantly elevated

Dimethylarsenic acid (DMA) was the active ingredient of Agent Blue, which was one of the herbicides used in Operation Ranch Hand. While not as well known as Agent Orange, nearly five million litres of Agent Blue were sprayed in Vietnam[9]. Arsenical agents have been known for many years to cause human cancers[15], particularly bladder cancers and non-melanocytic skin cancers, although recent reports have also suggested an increase in melanoma[8]. In the present study the rate of bladder cancer was not significantly elevated whereas the rate of non-melanocytic skin cancers could not be determined and the rate of melanoma was elevated. The environmental fate of the DMA after it was sprayed is poorly understood and its contribution to elevated cancer rates cannot be ruled out.

Asbestos

Asbestos is a known human carcinogen associated with an increased risk of several cancers, particularly lung cancer and also mesothelioma[15]. Asbestos exposure was also a factor experienced by many in this population. Some RAN ships of the time contained very large amounts of asbestos. The RAN transported approximately 15-16,000 Army and Air Force personnel to and from Vietnam[20, 21]. They may have experienced a level of onboard exposure. Further,

asbestos had a wide range of other applications at that time. For example, those involved in the construction industry were exposed in varying degrees to asbestos fibres. In the present study there was a higher than expected incidence for lung cancer for Army and Navy veterans but incidence rates for mesothelioma were not significantly different from the general population, except for Navy veterans who had a non-significant higher than expected incidence.

Fuels

Diesel fuel was used in Vietnam. Diesel fuel exhaust is a known human carcinogen, increasing risk for lung cancer[22]. Those involved in certain occupational groups, such as drivers and motor mechanics, may have had exposure to this carcinogenic material. Benzene, another known human carcinogen in particularly associated with myelogenous leukaemia, was also used in fuels during the Vietnam War[15]. However, the general population of Australians at that time also used both diesel and benzene fuels, and it is difficult to know if the Vietnam veteran cohort experienced a higher rate of exposure. In the present study, the rate of lung cancer was elevated and diesel fuel exposure could have contributed to this elevation. The rates of myeloid leukaemia were not different from expectations in the Army and Air Force. However, they were higher than expected for Navy veterans.

Malaria prophylaxis

Vietnam is endemic for malaria and it was necessary for personnel serving on land to take prophylaxis. The usual drug used was Paludrin but when resistance to this was detected, the Army decided to use dapsone. Although this provided good malaria protection, the complication rate was not acceptable and the malaria prophylaxis drug was changed back to chloroquine. The carcinogenic potential of dapsone among Army Vietnam veterans will be discussed in the fourth volume in this series.

Ultraviolet radiation

Vietnam veterans may also have experienced different patterns of ultraviolet exposure to that experienced by the general Australian population. Ultraviolet radiation is also a human carcinogen[23], associated with both melanoma and non-melanocytic skin cancer. This study showed that the rate of melanoma was higher than expected for Vietnam veterans in all Service branches.

7.5.2 Tobacco and alcohol consumption

Although smoking and alcohol consumption rates among Australian Vietnam veterans are not known, a survey of a sample of 641 Army veterans undertaken in the early 1990's indicated that a higher proportion of Vietnam veterans smoked and drank high levels of alcohol than among the general community[24]. One of the features of the history of the Vietnam War is that cigarettes and alcohol were available at very cheap prices, and this could have contributed to the higher rates of drinking and smoking. In addition, one of the well-documented sequelae of

service in a combat zone is an increased rate of psychiatric diseases, such as Post-traumatic Stress Disorder (PTSD). People who suffer from diseases such as PTSD are much more likely to suffer from co-morbid substance misuse, particularly alcohol consumption[25].

Both alcohol drinking and tobacco smoking are Class One IARC carcinogens. In some sites, such as the larynx, they have a synergistic effect[15].

Tobacco consumption

Increased levels of smoking when compared with the Australian population could explain increased levels of cancer. Cigarette smoking is an established carcinogenic habit in humans. It particularly contributes to lung cancer, but also contributes to cancer of the head and neck, larynx and oesophagus. Several of the cancers strongly correlated with smoking are elevated in this population. However, adenocarcinoma is the histological type that shows greatest elevation in this population, and is the type that has the weakest association with smoking. Furthermore, several tumours that are associated (albeit weakly) with smoking (such as stomach, oesophagus and pancreas) are not elevated in this population.

Alcohol consumption

There is very strong evidence that this population suffers from high levels of alcohol consumption. In 1998, a survey of Australia's surviving Vietnam veterans was undertaken, and 36% reported that they suffered from alcohol or drug misuse[26]. Further, a study undertaken on a random sample of Army Vietnam veterans showed that they had almost three times the rate of alcohol consumption of the general population[24].

Alcohol is an established human carcinogen, contributing to oesophageal cancer, laryngeal cancer and lung cancer. The high levels of alcohol consumption may have contributed to some of the higher levels of cancer in this group.

7.5.3 Involvement in other deployments

Some of the Australians who served in Vietnam were also involved in other deployments, some of which may have increased their risk of cancer.

For example, 2.7% of the Vietnam veteran study population also served in the war in Korea. Separate studies of Korean War veterans have shown that they, as a group, are at greater risk than the Australian population for the development of cancer[16]. This would increase the observed cancer rate in veterans who went on to serve in the Vietnam War. However, as the percentage of Vietnam veterans who served in other wars and deployments is not large, it is unlikely that service in multiple conflicts would be a major contributor to the changes in observed rates of cancer in the Vietnam veteran population.

7.5.4 Combat stress

All Australian Vietnam veterans would have had some exposure to combat stress albeit of varying degrees. There does not appear to be evidence that combat stress can directly affect the rate of cancer many years after the exposure. However, there are secondary mechanisms by which stress may have an effect such as alcohol and tobacco use.

7.6 Conclusions

This study of cancer incidence in male Australian military veterans of the Vietnam War has strengths – the size of the study, the quality of the data used and a high rate of ascertainment.

As discussed earlier in this chapter, the study has weaknesses, but those weaknesses can either be corrected for, or are likely to bias the result towards the null.

In conclusion, this study provides good evidence that Australian male veterans of the Vietnam War have an increased rate of cancer overall. There was an excess of 613 cancers; 88% of this excess consisted of lung cancers, oral cavity, pharynx and larynx cancers, prostate cancers and melanomas. Rates of melanoma, and to a lesser degree prostate cancer, were consistently elevated across Navy, Army and Air Force veterans, although patterns of other cancers were not consistent across the three groups. The reasons for these increases are unclear. In addition to exposure to known carcinogens, lifestyle changes, including alcohol and tobacco consumption, may play a role.

For several other malignancies, this study provides evidence suggesting that Australian Vietnam veterans may have rates significantly lower than the rate in the Australian population. These cancers include non-Hodgkin's lymphoma and multiple myeloma. Reasons for decreased rates are not clear but could relate to a healthy warrior effect.

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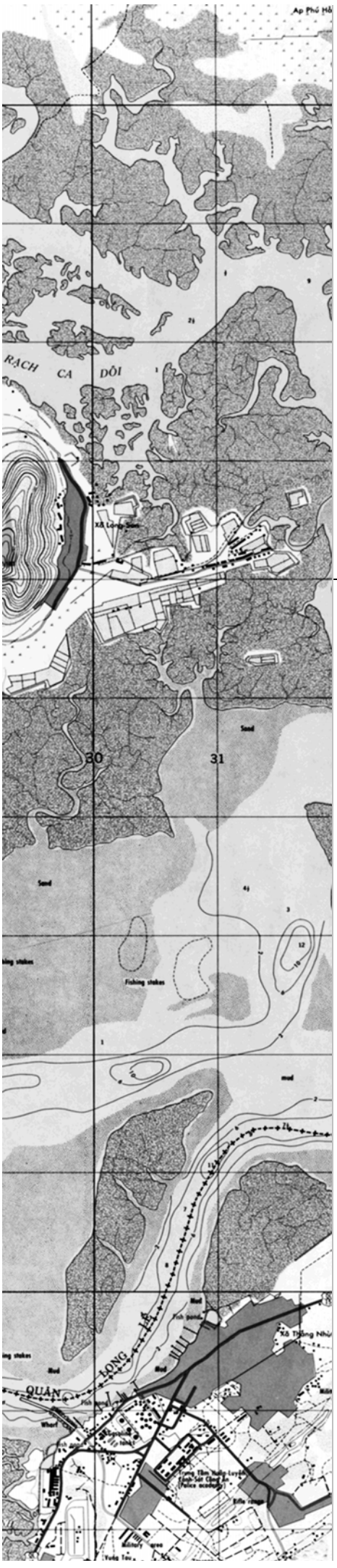


Study Protocol

Appendix A - 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 leukemia
NCSCH	National Cancer Statistics Clearing House
RAAF	Royal Australian Air Force
RAN	Royal Australian Navy
RR	Relative Risk (Ratio)
SMR	Standardised Mortality Ratio
VVMS	*Mortality of Vietnam Veterans: The veteran cohort study* 1997 report

A Protocol for the Third Vietnam Veteran Mortality Study and Cancer Incidence in Vietnam Veterans Study

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.

A.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 Appendix 1.

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.

A.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.

A.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.

A.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.

A.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 A.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

A.4 Comparisons of interest

A.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).

A.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.

A.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.

A.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 A.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
Leukemia	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

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.

A.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.

A.7 Data collection and processing

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

A.7.1 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.

A.7.2 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 2. A diagram of the proposed matching procedure for this study is also in Appendix 2. 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.

A.7.2.1 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.

A.7.2.2 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.

A.7.2.3 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.

A.7.2.4 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.

A.7.2.5 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.

A.7.2.6 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.

A.7.2.7 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.

A.7.2.8 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.

A.7.2.9 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.

A.8 Power of the study

Tables in Appendix 3 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 3 shows an example of power calculations for cancer incidence among Army veterans.

A.9 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.

A.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.

A.6 Legislation

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

A.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,

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.

A.10 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.

A.10.1 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.

A.10.2 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.

A.10.3 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.

A.10.4 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.

A.11 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.

A.12 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.

Appendix 1: 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

Study	Year	Type of Study	Results
"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

1 Fett M, Dunn M, Adena M, O'Toole B, Forcier L. Australian Veterans Health Studies: The Mortality Report, Part I: A retrospective cohort study of mortality among Australian National Servicemen of the Vietnam Conflict Era. Canberra: Commonwealth Institute of Health, 1984.

2 O'Toole B, Adena M, Fett M. The Australian Veteran Health Study, The Mortality Report, Part II: Factors influencing mortality rates of Australian Nation Servicemen of the Vietnam Conflict Era. Canberra: Department of Veterans Affairs, 1984.

3 Forcier L, Hudson H, Fett M. The Australian Veteran Health Study, The Mortality Report, Part III: The relationship between aspects of Vietnam service and subsequent mortality among Australian National Servicemen of the Vietnam Conflict Era. Canberra: Department of Veterans Affairs, 1984.

4 AIHW. Dapsone exposure, Vietnam service and cancer incidence. Canberra: Australian Institute of Health and Welfare, 1992:149.

5 AIHW. Vietnam service, dapsone use and cancer. Canberra: AIHW, 1994.

6 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.

7 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.

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.

9 Commonwealth Department of Veterans' Affairs. Morbidity of Vietnam Veterans: A Study of the Health of Australia's Vietnam Veteran Community. Volume 2: Female Vietnam Veterans. Canberra: Department of Veterans' Affairs, 1998.

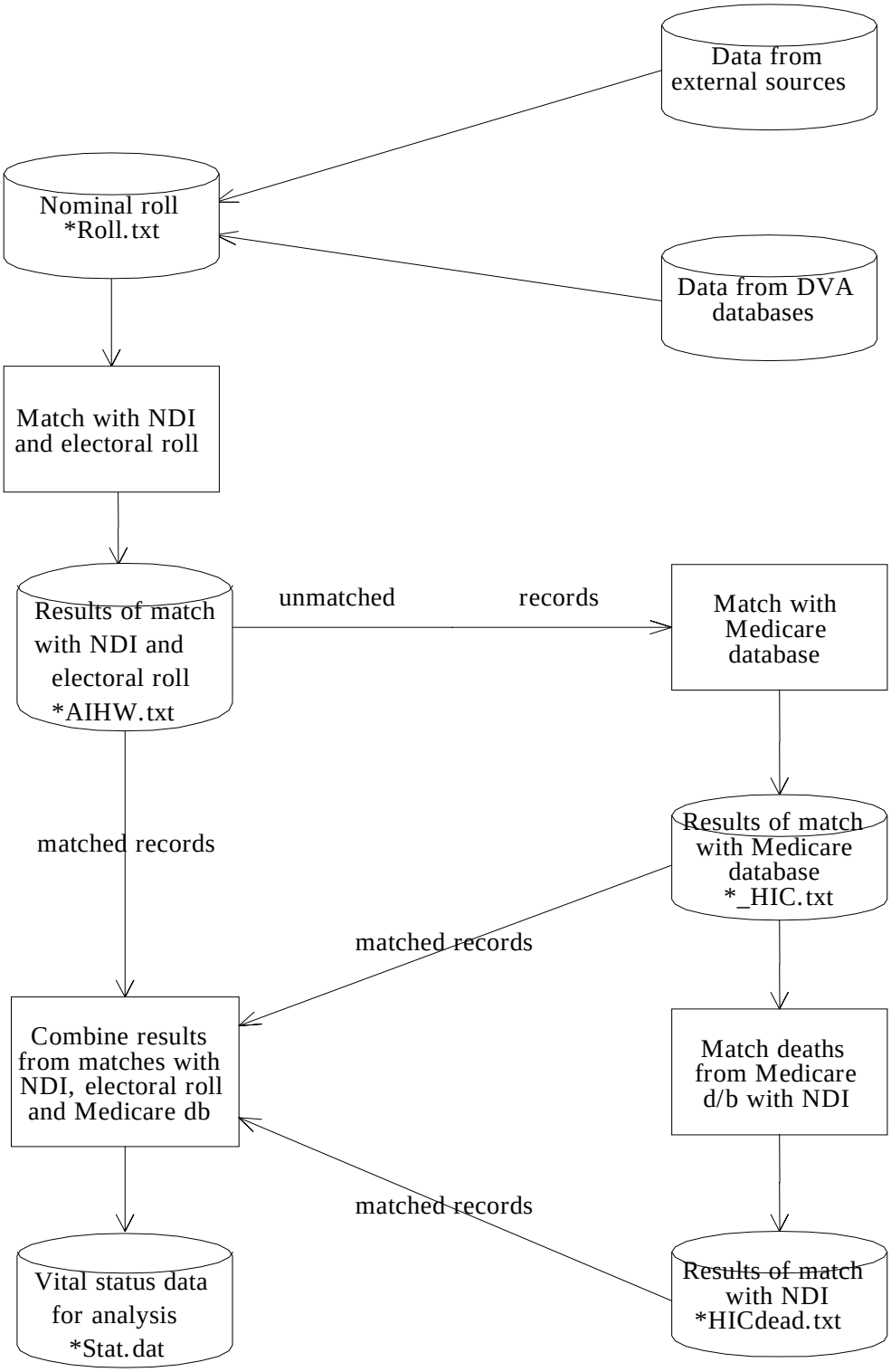
10 AIHW. Morbidity of Vietnam Veterans: A study of the Health of Australia's Vietnam Veteran Community: Vol 3, Validation study. Canberra: Australian Institute of Health and Welfare, 1999.

11 AIHW. Morbidity of Vietnam veterans: Suicide in Vietnam veterans' children: Supplementary report no 1. Canberra: Australian Institute of Health and Welfare, 2000:14.

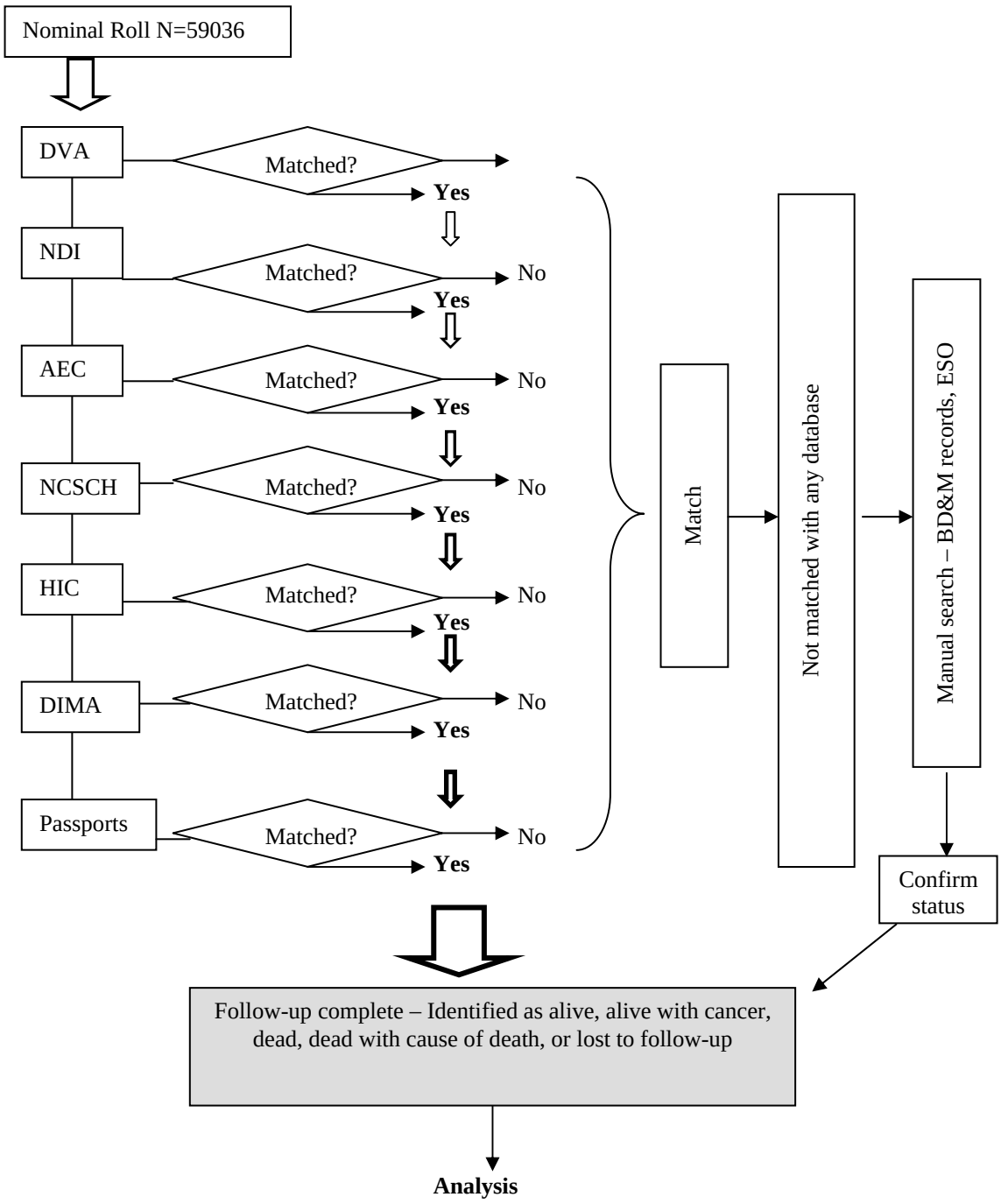
12 AIHW. Morbidity of Vietnam veterans: Adrenal gland cancer, leukaema and non-Hodgkin's lymphoma: Supplementary report no. 2. Canberra: Australian Institute of Health and Welfare, 2001.

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.

Appendix 2: Previous matching protocol



Appendix 2: 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.

Appendix 3: 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*	1101	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*	1492	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*	5258	1.1 (1.2)			
HMAS *Torrens*	253	1.4 (1.7)			
HMAS *Vampire*	1216	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	*16877*		*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

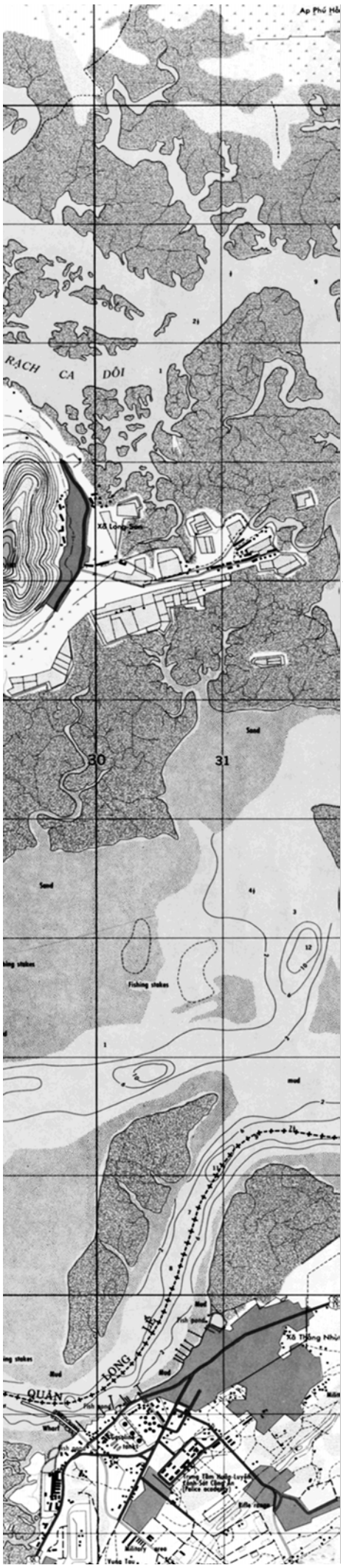
Power Calculations for Cancer Incidence

Disease (ICD-10)		Standardised Incidence 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	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	



Literature Review of Health Effects of Vietnam Service

Appendix B - 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
ICD10	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 risk
SIR	Standardised incidence rate
SMR	Standardised mortality rate
VAO	Veterans and Agent Orange report
VVMS	Vietnam Veterans Mortality Study, 1997

B Literature Review of Health Effects of Vietnam Service

B.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 3131 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).

B.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.

B.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.

B.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.

B.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.

B.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.

B.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.

B.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 leukemia 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.

B.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).

B.2.7 Other studies

B.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 leukemia in children of veterans.

B.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.

B.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.

B.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.

B.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.

B.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.

B.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]

B.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.

B.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

B.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.

B.3.2.5 Lung cancer (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).

B.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.

B.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.

B.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]

B.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]

B.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]

B.3.2.11 Non-Hodgkin's lymphoma (C82, C83, C85)

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]

B.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]

B.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.

B.3.2.14 Leukemia (C91-C95)

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

The VVMS did not demonstrate a significant association between Vietnam service and mortality from leukemia, 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 leukemia in veterans, 23 cases validated, 26 expected (95% CI 16, 36).[13]

Residents of Seveso showed a significant increase in myeloid leukemia after the dioxin accident, RR = 3.8 (95% CI 1.1, 12.5). Excess of leukemia 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 leukemia.

B.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.

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

This section does not include leukemias, 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]

B.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.

B.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.

B.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.

B.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]

B.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.

B.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.

B.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]

B.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]

B.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]

B.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]

B.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 B.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.
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

Study [a]	Year	Type of Study	Results
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.
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.
"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)

Study [a]	Year	Type of Study	Results
"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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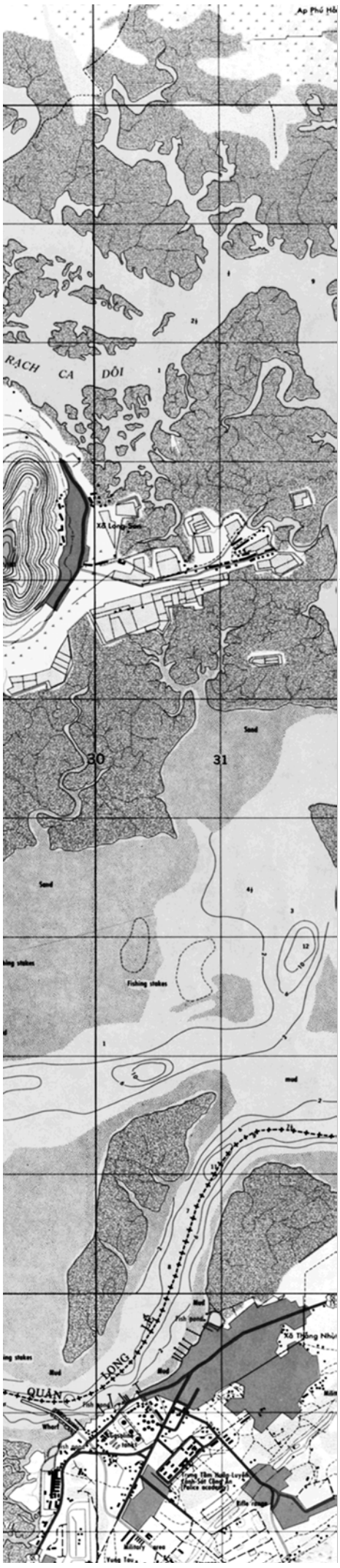


C

Tables of Results

Appendix C – Tables of Results

Table C.1: All Service branches, Vietnam veterans: Observed and expected number of cancers, and standardised incidence ratios (SIRs). Period examined: 1982–2000.

		Scenario 1 (excluding veterans whose status is unknown)			Scenario 2 (including veterans whose status is unknown)		
Cancer type	**Observed**	**Expected**	**SIR**	**95% CI**	**Expected**	**SIR**	**95% CI**
All cancers	4590	3977	1.15	1.12–1.19	4077	1.13	1.09–1.16
Brain	97	91	1.07	0.85–1.28	93	1.04	0.84–1.25
Breast	7	8	0.90	0.36–1.86	8	0.88	0.35–1.81
Connective soft tissue	35	36	0.99	0.66–1.31	36	0.96	0.64–1.28
Eye	27	15	1.75	1.09–2.41	16	1.71	1.06–2.35
Gastrointestinal	743	710	1.05	0.97–1.12	727	1.02	0.95–1.09
Colorectal	622	580	1.07	0.99–1.16	594	1.05	0.96–1.13
Colon	376	334	1.13	1.01–1.24	342	1.10	0.99–1.21
Rectum	234	236	0.99	0.86–1.12	242	0.97	0.84–1.09
Stomach	104	116	0.89	0.72–1.07	119	0.87	0.70–1.04
Genitourinary	1055	922	1.14	1.08–1.21	947	1.11	1.05–1.18
Bladder	164	157	1.04	0.88–1.20	161	1.02	0.86–1.17
Kidney	125	124	1.01	0.83–1.19	127	0.99	0.81–1.16
Prostate	692	553	1.25	1.16–1.34	570	1.21	1.12–1.31
Testis	54	62	0.87	0.63–1.10	64	0.85	0.62–1.07
Hodgkin's disease	51	25	2.05	1.49–2.61	25	2.01	1.45–2.56
Leukaemia	130	110	1.18	0.98–1.38	113	1.15	0.95–1.35
Lymphoid	72	52	1.38	1.06–1.69	54	1.34	1.03–1.65
LL_acute	9	7	1.29	0.59–2.44	7	1.26	0.58–2.39
LL_chronic	58	37	1.55	1.15–1.95	38	1.51	1.12–1.90
Myeloid leukaemia	54	52	1.03	0.75–1.30	54	1.00	0.74–1.27
ML_acute	30	29	1.04	0.67–1.42	29	1.02	0.65–1.38
ML_chronic	21	17	1.20	0.69–1.71	18	1.17	0.67–1.67
Liver	27	38	0.70	0.44–0.97	39	0.69	0.43–0.95
Lung	576	468	1.23	1.13–1.33	480	1.20	1.10–1.30
Adenocarcinoma	188	130	1.45	1.24–1.66	133	1.41	1.21–1.62
Squamous	152	127	1.19	1.00–1.38	131	1.16	0.98–1.35
Small-cell	87	71	1.23	0.97–1.49	73	1.20	0.95–1.45
Large-cell	79	74	1.07	0.83–1.31	76	1.04	0.81–1.27
Other	70	66	1.06	0.81–1.30	68	1.03	0.79–1.27
Melanoma	756	573	1.32	1.23–1.41	586	1.29	1.20–1.38
Mesothelioma	27	34	0.81	0.50–1.11	34	0.79	0.49–1.08
Multiple myeloma	31	47	0.66	0.43–0.90	48	0.65	0.42–0.88
NHL	126	189	0.67	0.55–0.79	193	0.65	0.54–0.77
Oesophagus	70	57	1.22	0.94–1.51	59	1.19	0.91–1.47
Oral cavity, pharynx & larynx	344	233	1.47	1.32–1.63	239	1.44	1.29–1.59
Head and neck	247	167	1.48	1.29–1.66	171	1.44	1.26–1.63
Larynx	97	66	1.46	1.17–1.75	68	1.43	1.14–1.71
Pancreas	86	75	1.15	0.91–1.40	77	1.12	0.89–1.36
Thyroid	17	30	0.57	0.33–0.92	30	0.56	0.33–0.90
Unknown	143	135	1.06	0.89–1.24	138	1.04	0.87–1.21

Table C.2: Navy Vietnam veterans: Observed and expected number of cancers, and standardised incidence ratios (SIRs). Period examined: 1982–2000.

		Scenario 1 (excluding veterans whose status is unknown)			Scenario 2 (including veterans whose status is unknown)		
Cancer type	**Observed**	**Expected**	**SIR**	**95% CI**	**Expected**	**SIR**	**95% CI**
All cancers	1073	854	1.26	1.18, 1.33	881	1.22	1.15, 1.29
Brain	24	20	1.20	0.72, 1.68	21	1.17	0.70, 1.64
Breast	1	2	0.59	0.01, 3.28	2	0.57	0.01, 3.18
Connective soft tissue	6	8	0.77	0.28, 1.67	8	0.75	0.27, 1.63
Eye	2	3	0.60	0.07, 2.16	3	0.58	0.07, 2.10
Gastrointestinal	178	152	1.17	1.00, 1.35	156	1.14	0.97, 1.31
Colorectal	147	124	1.18	0.99, 1.38	128	1.15	0.96, 1.33
Colon	91	71	1.28	1.01, 1.54	74	1.24	0.98, 1.49
Rectum	54	51	1.07	0.78, 1.35	52	1.04	0.76, 1.31
Stomach	28	25	1.13	0.71, 1.55	25	1.10	0.69, 1.51
Genitourinary	226	195	1.16	1.01, 1.31	202	1.12	0.97, 1.27
Bladder	34	33	1.03	0.69, 1.38	34	1.00	0.66, 1.34
Kidney	34	27	1.28	0.85, 1.70	27	1.24	0.82, 1.66
Prostate	137	115	1.19	0.99, 1.39	119	1.15	0.95, 1.34
Testis	17	15	1.15	0.67, 1.84	15	1.12	0.65, 1.80
Hodgkin's disease	7	6	1.25	0.50, 2.57	6	1.22	0.49, 2.50
Leukaemia	35	24	1.47	0.98, 1.96	24	1.43	0.96, 1.90
Lymphoid	14	11	1.24	0.68, 2.08	12	1.20	0.66, 2.02
LL_acute	1	2	0.63	0.02, 3.50	2	0.61	0.02, 3.41
LL_chronic	12	8	1.51	0.78, 2.63	8	1.46	0.75, 2.55
Myeloid leukaemia	19	11	1.68	1.01, 2.63	12	1.63	0.98, 2.55
ML_acute	11	6	1.79	0.89, 3.20	6	1.73	0.87, 3.10
ML_chronic	8	4	2.09	0.92, 4.11	4	2.03	0.90, 3.99
Liver	8	8	0.96	0.42, 1.88	9	0.93	0.41, 1.82
Lung	141	99	1.43	1.19, 1.67	102	1.38	1.16, 1.61
Adenocarcinoma	52	28	1.88	1.37, 2.40	28	1.83	1.33, 2.32
Squamous	35	27	1.31	0.87, 1.74	28	1.26	0.84, 1.68
Small-cell	15	15	1.00	0.56, 1.66	15	0.97	0.55, 1.61
Large-cell	23	16	1.48	0.88, 2.09	16	1.44	0.85, 2.02
Other	16	14	1.16	0.67, 1.89	14	1.13	0.64, 1.83
Melanoma	173	126	1.37	1.17, 1.57	130	1.33	1.13, 1.53
Mesothelioma	12	7	1.70	0.88, 2.96	7	1.65	0.85, 2.87
Multiple myeloma	4	10	0.40	0.11, 1.03	10	0.39	0.11, 1.00
NHL	31	41	0.76	0.49, 1.02	42	0.74	0.48, 0.99
Oesophagus	19	12	1.56	0.94, 2.44	13	1.51	0.91, 2.36
Oral cavity, pharynx & larynx	77	50	1.53	1.19, 1.87	52	1.49	1.15, 1.82
Head and neck	56	36	1.55	1.14, 1.95	37	1.50	1.11, 1.90
Larynx	21	14	1.49	0.85, 2.12	15	1.44	0.83, 2.06
Pancreas	14	16	0.89	0.48, 1.49	16	0.86	0.47, 1.44
Thyroid	3	7	0.45	0.09, 1.30	7	0.43	0.09, 1.27
Unknown	41	29	1.43	1.00, 1.87	29	1.39	0.96, 1.82

Table C.3: Army Vietnam veterans: Observed and expected number of cancers, and standardised incidence ratios (SIRs). Period examined: 1982–2000.

		Scenario 1 (excluding veterans whose status is unknown)			Scenario 2 (including veterans whose status is unknown)		
Cancer type	**Observed**	**Expected**	**SIR**	**95% CI**	**Expected**	**SIR**	**95% CI**
All cancers	3013	2657	1.13	1.09, 1.17	2719	1.11	1.07, 1.15
Brain	63	62	1.01	0.76, 1.26	63	0.99	0.75, 1.24
Breast	5	5	0.97	0.31, 2.26	5	0.94	0.31, 2.21
Connective soft tissue	29	24	1.19	0.76, 1.63	25	1.17	0.74, 1.59
Eye	21	11	1.99	1.14, 2.84	11	1.95	1.11, 2.78
Gastrointestinal	479	472	1.02	0.92, 1.11	482	0.99	0.90, 1.08
Colorectal	399	385	1.04	0.93, 1.14	394	1.01	0.91, 1.11
Colon	239	221	1.08	0.94, 1.22	226	1.06	0.92, 1.19
Rectum	152	157	0.97	0.81, 1.12	161	0.95	0.80, 1.10
Stomach	66	78	0.85	0.65, 1.06	79	0.83	0.63, 1.03
Genitourinary	678	605	1.12	1.04, 1.20	620	1.09	1.01, 1.18
Bladder	104	104	1.00	0.81, 1.19	106	0.98	0.79, 1.16
Kidney	77	84	0.92	0.71, 1.12	86	0.90	0.70, 1.10
Prostate	451	357	1.27	1.15, 1.38	366	1.23	1.12, 1.35
Testis	34	44	0.78	0.52, 1.04	45	0.76	0.51, 1.02
Hodgkin's disease	40	17	2.31	1.59, 3.02	18	2.26	1.56, 2.96
Leukaemia	80	74	1.07	0.84, 1.31	76	1.05	0.82, 1.28
Lymphoid	50	35	1.42	1.03, 1.82	36	1.39	1.01, 1.78
LL_acute	5	5	1.04	0.34, 2.42	5	1.02	0.33, 2.37
LL_chronic	42	25	1.68	1.18, 2.19	26	1.65	1.15, 2.14
Myeloid leukaemia	28	36	0.78	0.49, 1.07	37	0.77	0.48, 1.05
ML_acute	15	19	0.77	0.43, 1.27	20	0.75	0.42, 1.24
ML_chronic	10	12	0.84	0.40, 1.54	12	0.82	0.39, 1.50
Liver	18	25	0.71	0.42, 1.12	26	0.69	0.41, 1.10
Lung	372	306	1.22	1.09, 1.34	313	1.19	1.07, 1.31
Adenocarcinoma	122	85	1.43	1.18, 1.69	87	1.40	1.15, 1.65
Squamous	99	82	1.21	0.97, 1.44	84	1.18	0.95, 1.41
Small-cell	61	46	1.32	0.99, 1.65	47	1.29	0.96, 1.61
Large-cell	46	49	0.94	0.67, 1.22	50	0.92	0.66, 1.19
Other	44	43	1.02	0.72, 1.32	44	0.99	0.70, 1.28
Melanoma	510	394	1.29	1.18, 1.41	402	1.27	1.16, 1.38
Mesothelioma	14	22	0.63	0.34, 1.05	23	0.61	0.33, 1.03
Multiple myeloma	21	31	0.67	0.38, 0.96	32	0.66	0.38, 0.94
NHL	86	129	0.67	0.53, 0.81	132	0.65	0.52, 0.79
Oesophagus	40	38	1.05	0.73, 1.38	39	1.03	0.71, 1.35
Oral cavity, pharynx & larynx	243	156	1.55	1.36, 1.75	160	1.52	1.33, 1.71
Head and neck	174	113	1.55	1.32, 1.78	115	1.51	1.29, 1.74
Larynx	69	44	1.57	1.20, 1.94	45	1.54	1.18, 1.90
Pancreas	60	50	1.21	0.90, 1.51	51	1.18	0.88, 1.48
Thyroid	11	20	0.54	0.27, 0.96	21	0.53	0.26, 0.94
Unknown	87	89	0.97	0.77, 1.18	91	0.95	0.75, 1.15

Table C.4: Air Force Vietnam veterans: Observed and expected number of cancers, and standardised incidence ratios (SIRs). Period examined: 1982–2000.

		Scenario 1 (excluding veterans whose status is unknown)			Scenario 2 (including veterans whose status is unknown)		
Cancer type	**Observed**	**Expected**	**SIR**	**95% CI**	**Expected**	**SIR**	**95% CI**
All cancers	505	466	1.08	0.99, 1.18	478	1.06	0.96, 1.15
Brain	10	9	1.14	0.55, 2.09	9	1.11	0.53, 2.05
Breast	1	1	1.12	0.03, 6.25	1	1.09	0.03, 6.09
Connective soft tissue	0	3	0.00	0.00, 1.08	3	0.00	0.00, 1.06
Eye	4	2	2.61	0.71, 6.69	2	2.55	0.70, 6.54
Gastrointestinal	87	86	1.01	0.80, 1.22	89	0.98	0.77, 1.19
Colorectal	77	71	1.09	0.84, 1.33	73	1.06	0.82, 1.29
Colon	47	41	1.13	0.81, 1.46	43	1.11	0.79, 1.42
Rectum	28	28	0.98	0.62, 1.35	29	0.96	0.60, 1.31
Stomach	10	14	0.71	0.34, 1.31	14	0.69	0.33, 1.27
Genitourinary	151	122	1.24	1.04, 1.44	125	1.20	1.01, 1.40
Bladder	26	20	1.29	0.79, 1.79	21	1.25	0.77, 1.74
Kidney	14	13	1.06	0.58, 1.78	14	1.03	0.57, 1.74
Prostate	104	82	1.28	1.03, 1.52	84	1.24	1.00, 1.47
Testis	3	4	0.78	0.16, 2.28	4	0.77	0.16, 2.25
Hodgkin's disease	4	2	2.05	0.56, 5.25	2	2.01	0.55, 5.15
Leukaemia	15	12	1.23	0.69, 2.03	12	1.20	0.67, 1.98
Lymphoid	8	6	1.35	0.60, 2.66	6	1.31	0.58, 2.59
LL_acute	3	1	5.10	1.05, 14.90	1	4.98	1.03, 14.57
LL_chronic	4	5	0.87	0.24, 2.23	5	0.85	0.23, 2.17
Myeloid leukaemia	7	6	1.27	0.51, 2.61	6	1.23	0.50, 2.54
ML_acute	4	3	1.27	0.35, 3.26	3	1.24	0.34, 3.18
ML_chronic	3	2	1.77	0.36, 5.17	2	1.73	0.36, 5.05
Liver	1	5	0.22	0.01, 1.21	5	0.21	0.01, 1.18
Lung	63	64	0.99	0.74, 1.23	66	0.96	0.72, 1.20
Adenocarcinoma	14	17	0.83	0.45, 1.40	17	0.81	0.44, 1.36
Squamous	18	19	0.97	0.57, 1.53	19	0.94	0.56, 1.48
Small-cell	11	10	1.15	0.58, 2.06	10	1.12	0.56, 2.01
Large-cell	10	10	1.05	0.50, 1.93	10	1.02	0.49, 1.88
Other	10	9	1.08	0.52, 1.98	10	1.04	0.50, 1.92
Melanoma	73	52	1.40	1.08, 1.72	53	1.37	1.05, 1.68
Mesothelioma	1	4	0.24	0.01, 1.35	4	0.24	0.01, 1.32
Multiple myeloma	6	5	1.09	0.40, 2.38	6	1.06	0.39, 2.31
NHL	9	19	0.48	0.22, 0.91	19	0.47	0.21, 0.89
Oesophagus	11	7	1.54	0.77, 2.76	7	1.50	0.75, 2.69
Oral cavity, pharynx & larynx	24	27	0.90	0.54, 1.26	27	0.88	0.53, 1.23
Head and neck	17	18	0.93	0.54, 1.49	19	0.91	0.53, 1.45
Larynx	7	8	0.84	0.34, 1.73	9	0.82	0.33, 1.69
Pancreas	12	9	1.30	0.67, 2.27	9	1.27	0.65, 2.21
Thyroid	3	3	1.18	0.24, 3.45	3	1.16	0.24, 3.38
Unknown	15	17	0.89	0.50, 1.47	17	0.87	0.49, 1.43

Table C.5: By Service branch, Vietnam veterans: Standardised incidence ratios (SIRs) and confidence intervals by type of cancer using scenario 1 (excluding veterans whose status is unknown). Period examined 1982–2000.

	All veterans		Navy		Army		RAAF	
Cancer type	**SIR**	**95% CI**	**SIR**	**95% CI**	**SIR**	**95% CI**	**SIR**	**95% CI**
All cancers	1.15	1.12–1.19	1.26	1.18, 1.33	1.13	1.09–1.17	1.08	0.99, 1.18
Brain	1.07	0.85–1.28	1.20	0.72, 1.68	1.01	0.76–1.26	1.14	0.55, 2.09
Breast	0.90	0.36–1.86	0.59	0.01, 3.28	0.97	0.31–2.26	1.12	0.03, 6.25
Connective soft tissue	0.99	0.66–1.31	0.77	0.28, 1.67	1.19	0.76–1.63	0.00	0.00, 1.08
Eye	1.75	1.09–2.41	0.60	0.07, 2.16	1.99	1.14–2.84	2.61	0.71, 6.69
Gastrointestinal	1.05	0.97–1.12	1.17	1.00, 1.35	1.02	0.92–1.11	1.01	0.80, 1.22
Colorectal	1.07	0.99–1.16	1.18	0.99, 1.38	1.04	0.93–1.14	1.09	0.84, 1.33
Colon	1.13	1.01–1.24	1.28	1.01, 1.54	1.08	0.94–1.22	1.13	0.81, 1.46
Rectum	0.99	0.86–1.12	1.07	0.78, 1.35	0.97	0.81–1.12	0.98	0.62, 1.35
Stomach	0.89	0.72–1.07	1.13	0.71, 1.55	0.85	0.65–1.06	0.71	0.34, 1.31
Genitourinary	1.14	1.08–1.21	1.16	1.01, 1.31	1.12	1.04–1.20	1.24	1.04, 1.44
Bladder	1.04	0.88–1.20	1.03	0.69, 1.38	1.00	0.81–1.19	1.29	0.79, 1.79
Kidney	1.01	0.83–1.19	1.28	0.85, 1.70	0.92	0.71–1.12	1.06	0.58, 1.78
Prostate	1.25	1.16–1.34	1.19	0.99, 1.39	1.27	1.15–1.38	1.28	1.03, 1.52
Testis	0.87	0.63–1.10	1.15	0.67, 1.84	0.78	0.52–1.04	0.78	0.16, 2.28
Hodgkin's disease	2.05	1.49–2.61	1.25	0.50, 2.57	2.31	1.59–3.02	2.05	0.56, 5.25
Leukaemia	1.18	0.98–1.38	1.47	0.98, 1.96	1.07	0.84–1.31	1.23	0.69, 2.03
Lymphoid leukaemia	1.38	1.06–1.69	1.24	0.68, 2.08	1.42	1.03–1.82	1.35	0.60, 2.66
LL_acute	1.29	0.59–2.44	0.63	0.02, 3.50	1.04	0.34–2.42	5.10	1.05, 14.90
LL_chronic	1.55	1.15–1.95	1.51	0.78, 2.63	1.68	1.18–2.19	0.87	0.24, 2.23
Myeloid leukaemia	1.03	0.75–1.30	1.68	1.01, 2.63	0.78	0.49–1.07	1.27	0.51, 2.61
ML_acute	1.04	0.67–1.42	1.79	0.89, 3.20	0.77	0.43–1.27	1.27	0.35, 3.26
ML_chronic	1.20	0.69–1.71	2.09	0.92, 4.11	0.84	0.40–1.54	1.77	0.36, 5.17
Liver	0.70	0.44–0.97	0.96	0.42, 1.88	0.71	0.42–1.12	0.22	0.01, 1.21
Lung	1.23	1.13–1.33	1.43	1.19, 1.67	1.22	1.09–1.34	0.99	0.74, 1.23
Adenocarcinoma	1.45	1.24–1.66	1.88	1.37, 2.40	1.43	1.18–1.69	0.83	0.45, 1.40
Squamous	1.19	1.00–1.38	1.31	0.87, 1.74	1.21	0.97–1.44	0.97	0.57, 1.53
Small-cell	1.23	0.97–1.49	1.00	0.56, 1.66	1.32	0.99–1.65	1.15	0.58, 2.06
Large-cell	1.07	0.83–1.31	1.48	0.88, 2.09	0.94	0.67–1.22	1.05	0.50, 1.93
Other	1.06	0.81–1.30	1.16	0.67, 1.89	1.02	0.72–1.32	1.08	0.52, 1.98
Melanoma	1.32	1.23–1.41	1.37	1.17, 1.57	1.29	1.18–1.41	1.40	1.08, 1.72
Mesothelioma	0.81	0.50–1.11	1.70	0.88, 2.96	0.63	0.34–1.05	0.24	0.01, 1.35
Multiple myeloma	0.66	0.43–0.90	0.40	0.11, 1.03	0.67	0.38–0.96	1.09	0.40, 2.38
NHL	0.67	0.55–0.79	0.76	0.49, 1.02	0.67	0.53–0.81	0.48	0.22, 0.91
Oesophagus	1.22	0.94–1.51	1.56	0.94, 2.44	1.05	0.73–1.38	1.54	0.77, 2.76
Oral cavity, pharynx & larynx	1.47	1.32–1.63	1.53	1.19, 1.87	1.55	1.36–1.75	0.90	0.54, 1.26
Head and neck	1.48	1.29–1.66	1.55	1.14, 1.95	1.55	1.32–1.78	0.93	0.54, 1.49
Larynx	1.46	1.17–1.75	1.49	0.85, 2.12	1.57	1.20–1.94	0.84	0.34, 1.73
Pancreas	1.15	0.91–1.40	0.89	0.48, 1.49	1.21	0.90–1.51	1.30	0.67, 2.27
Thyroid	0.57	0.33–0.92	0.45	0.09, 1.30	0.54	0.27–0.96	1.18	0.24, 3.45
Unknown	1.06	0.89–1.24	1.43	1.00, 1.87	0.97	0.77–1.18	0.89	0.50, 1.47

Table C.6: Australian Army Training Team Vietnam veterans: Observed and expected number of cancers, and standardised incidence ratios (SIRs). Period examined: 1982–2000.

		Scenario 1 (excluding veterans whose status is unknown)			Scenario 2 (including veterans whose status is unknown)		
Cancer type	**Observed**	**Expected**	**SIR**	**95% CI**	**Expected**	**SIR**	**95% CI**
All cancers	105	85	1.24	1.00, 1.47	87	1.21	0.98, 1.44
Brain	1	1	0.73	0.02, 4.09	1	0.72	0.02, 4.02
Breast	1	0	6.20	0.16, 34.55	0	6.08	0.15, 33.87
Connective soft tissue	0	1	0.00	0.00, 6.91	1	0.00	0.00, 6.79
Eye	1	0	4.06	0.10, 22.65	0	3.99	0.10, 22.24
Gastrointestinal	14	16	0.87	0.48, 1.46	16	0.85	0.47, 1.43
Colorectal	11	13	0.83	0.41, 1.49	14	0.81	0.41, 1.46
Colon	6	8	0.77	0.28, 1.68	8	0.76	0.28, 1.64
Rectum	5	5	0.95	0.31, 2.22	5	0.93	0.30, 2.17
Stomach	3	3	1.14	0.24, 3.34	3	1.12	0.23, 3.28
Genitourinary	30	24	1.25	0.80, 1.70	24	1.23	0.79, 1.66
Bladder	5	4	1.28	0.42, 2.99	4	1.26	0.41, 2.93
Kidney	5	2	2.24	0.73, 5.23	2	2.20	0.71, 5.13
Prostate	20	17	1.18	0.72, 1.82	17	1.15	0.70, 1.78
Testis	0	0	0.00	0.00, 11.88	0	0.00	0.00, 11.75
Hodgkin's disease	1	0	4.03	0.10, 22.48	0	3.96	0.10, 22.10
Leukemia	2	2	0.95	0.11, 3.42	2	0.93	0.11, 3.36
Lymphoid leukemia	0	1	0.00	0.00, 3.50	1	0.00	0.00, 3.43
LL_acute	0	0	0.00	0.00, 45.13	0	0.00	0.00, 44.38
LL_chronic	0	1	0.00	0.00, 4.28	1	0.00	0.00, 4.20
Myeloid leukemia	2	1	2.16	0.26, 7.81	1	2.12	0.26, 7.66
ML_acute	2	1	3.67	0.44, 13.26	1	3.60	0.44, 13.01
ML_chronic	0	0	0.00	0.00, 14.27	0	0.00	0.00, 14.02
Liver	2	1	2.35	0.28, 8.49	1	2.30	0.28, 8.32
Lung	12	13	0.93	0.48, 1.63	13	0.91	0.47, 1.60
Adenocarcinoma	3	3	0.91	0.19, 2.65	3	0.89	0.18, 2.60
Squamous	3	4	0.77	0.16, 2.25	4	0.75	0.16, 2.20
Small-cell	1	2	0.52	0.01, 2.91	2	0.51	0.01, 2.85
Large-cell	2	2	1.07	0.13, 3.88	2	1.05	0.13, 3.80
Other	3	2	1.60	0.33, 4.66	2	1.56	0.32, 4.57
Melanoma	12	8	1.57	0.81, 2.74	8	1.54	0.80, 2.69
Mesothelioma	0	1	0.00	0.00, 4.78	1	0.00	0.00, 4.69
Multiple myeloma	0	1	0.00	0.00, 3.71	1	0.00	0.00, 3.64
NHL	4	3	1.34	0.37, 3.43	3	1.32	0.36, 3.37
Oesophagus	1	1	0.74	0.02, 4.11	1	0.72	0.02, 4.03
Oral cavity, pharynx & larynx	12	5	2.51	1.29, 4.38	5	2.46	1.27, 4.29
Head and neck	9	3	2.83	1.30, 5.37	3	2.78	1.27, 5.27
Larynx	3	2	1.86	0.38, 5.44	2	1.83	0.38, 5.34
Pancreas	3	2	1.72	0.36, 5.04	2	1.69	0.35, 4.94
Thyroid	0	0	0.00	0.00, 10.72	0	0.00	0.00, 10.54
Unknown	4	3	1.25	0.34, 3.20	3	1.23	0.33, 3.14

Table C.7: 32 Small Ship Squadron, Army Vietnam veterans: Observed and expected number of cancers, and standardised incidence ratios (SIRs). Period examined: 1982–2000.

		Scenario 1 (excluding veterans whose status is unknown)			Scenario 2 (including veterans whose status is unknown)		
Cancer type	**Observed**	**Expected**	**SIR**	**95% CI**	**Expected**	**SIR**	**95% CI**
All cancers	40	36	1.11	0.77, 1.46	36	1.10	0.76, 1.44
Brain	0	1	0.00	0.00, 4.52	1	0.00	0.00, 4.46
Breast	0	0	0.00	0.00, 53.74	0	0.00	0.00, 52.95
Connective soft tissue	0	0	0.00	0.00, 11.60	0	0.00	0.00, 11.46
Eye	0	0	0.00	0.00, 26.40	0	0.00	0.00, 26.07
Gastrointestinal	5	6	0.78	0.25, 1.83	6	0.77	0.25, 1.80
Colorectal	3	5	0.58	0.12, 1.68	5	0.57	0.12, 1.66
Colon	1	3	0.33	0.01, 1.86	3	0.33	0.01, 1.83
Rectum	0	2	0.00	0.00, 1.74	2	0.00	0.00, 1.72
Stomach	2	1	1.89	0.23, 6.83	1	1.86	0.23, 6.73
Genitourinary	9	8	1.08	0.50, 2.05	8	1.06	0.49, 2.02
Bladder	2	1	1.39	0.17, 5.03	1	1.37	0.17, 4.95
Kidney	0	1	0.00	0.00, 3.30	1	0.00	0.00, 3.25
Prostate	5	5	1.00	0.33, 2.34	5	0.99	0.32, 2.30
Testis	2	1	3.67	0.44, 13.26	1	3.64	0.44, 13.15
Hodgkin's disease	1	0	4.48	0.11, 25.00	0	4.44	0.11, 24.75
Leukemia	0	1	0.00	0.00, 3.69	1	0.00	0.00, 3.64
Lymphoid leukemia	0	0	0.00	0.00, 7.84	0	0.00	0.00, 7.73
LL_acute	0	0	0.00	0.00, 59.58	0	0.00	0.00, 58.89
LL_chronic	0	0	0.00	0.00, 10.91	0	0.00	0.00, 10.74
Myeloid leukemia	0	0	0.00	0.00, 7.72	0	0.00	0.00, 7.61
ML_acute	0	0	0.00	0.00, 14.09	0	0.00	0.00, 13.90
ML_chronic	0	0	0.00	0.00, 23.21	0	0.00	0.00, 22.91
Liver	0	0	0.00	0.00, 10.82	0	0.00	0.00, 10.66
Lung	6	4	1.40	0.51, 3.05	4	1.38	0.51, 3.00
Adenocarcinoma	3	1	2.56	0.53, 7.48	1	2.52	0.52, 7.37
Squamous	1	1	0.85	0.02, 4.73	1	0.83	0.02, 4.65
Small-cell	0	1	0.00	0.00, 5.66	1	0.00	0.00, 5.58
Large-cell	1	1	1.48	0.04, 8.26	1	1.46	0.04, 8.13
Other	1	1	1.63	0.04, 9.10	1	1.60	0.04, 8.94
Melanoma	7	5	1.37	0.55, 2.81	5	1.35	0.54, 2.78
Mesothelioma	0	0	0.00	0.00, 12.19	0	0.00	0.00, 12.01
Multiple myeloma	0	0	0.00	0.00, 8.75	0	0.00	0.00, 8.62
NHL	5	2	2.94	0.96, 6.87	2	2.91	0.94, 6.79
Oesophagus	0	1	0.00	0.00, 7.12	1	0.00	0.00, 7.01
Oral cavity, pharynx & larynx	2	2	0.95	0.12, 3.43	2	0.94	0.11, 3.39
Head and neck	1	2	0.67	0.02, 3.71	2	0.66	0.02, 3.66
Larynx	1	1	1.66	0.04, 9.24	1	1.63	0.04, 9.10
Pancreas	2	1	2.94	0.36, 10.62	1	2.90	0.35, 10.46
Thyroid	0	0	0.00	0.00, 14.05	0	0.00	0.00, 13.90
Unknown	2	1	1.64	0.20, 5.92	1	1.61	0.20, 5.83

Table C.8: HMAS *Melbourne*, Navy Vietnam veterans: Observed and expected number of cancers, and standardised incidence ratios (SIRs). Period examined: 1982–2000.

		Scenario 1 (excluding veterans whose status is unknown)			Scenario 2 (including veterans whose status is unknown)		
Cancer type	**Observed**	**Expectedd**	**SIR**	**95% CI**	**Expected**	**SIR**	**95% CI**
All cancers	141	114	1.23	1.03, 1.43	119	1.18	0.99, 1.38
Brain	1	2	0.44	0.01, 2.45	2	0.42	0.01, 2.36
Breast	0	0	0.00	0.00, 16.92	0	0.00	0.00, 16.28
Connective soft tissue	1	1	1.15	0.03, 6.40	1	1.11	0.03, 6.17
Eye	1	0	2.55	0.06, 14.23	0	2.46	0.06, 13.71
Gastrointestinal	28	21	1.31	0.83, 1.80	22	1.26	0.79, 1.73
Colorectal	26	18	1.48	0.91, 2.05	18	1.43	0.88, 1.97
Colon	19	10	1.87	1.12, 2.92	11	1.79	1.08, 2.80
Rectum	7	7	0.99	0.40, 2.04	7	0.95	0.38, 1.96
Stomach	2	3	0.58	0.07, 2.11	4	0.56	0.07, 2.02
Genitourinary	34	29	1.18	0.78, 1.57	30	1.13	0.75, 1.50
Bladder	8	5	1.66	0.74, 3.27	5	1.59	0.70, 3.13
Kidney	5	3	1.49	0.48, 3.47	3	1.43	0.47, 3.34
Prostate	20	19	1.06	0.65, 1.63	20	1.01	0.62, 1.56
Testis	0	1	0.00	0.00, 3.59	1	0.00	0.00, 3.48
Hodgkin's disease	0	1	0.00	0.00, 7.24	1	0.00	0.00, 7.00
Leukaemia	5	3	1.66	0.54, 3.86	3	1.59	0.52, 3.71
Lymphoid	2	1	1.36	0.16, 4.90	2	1.30	0.16, 4.71
LL_acute	1	0	6.68	0.17, 37.26	0	6.44	0.16, 35.88
LL_chronic	1	1	0.89	0.02, 4.95	1	0.85	0.02, 4.76
Myeloid leukaemia	3	1	2.18	0.45, 6.37	1	2.09	0.43, 6.10
ML_acute	2	1	2.56	0.31, 9.25	1	2.46	0.30, 8.88
ML_chronic	1	0	2.31	0.06, 12.87	0	2.22	0.06, 12.35
Liver	2	1	1.77	0.21, 6.39	1	1.70	0.21, 6.14
Lung	15	15	0.99	0.55, 1.63	16	0.95	0.53, 1.57
Adenocarcinoma	4	4	0.98	0.27, 2.51	4	0.94	0.26, 2.41
Squamous	7	4	1.62	0.65, 3.33	5	1.55	0.62, 3.19
Small-cell	1	2	0.44	0.01, 2.43	2	0.42	0.01, 2.34
Large-cell	3	2	1.31	0.27, 3.82	2	1.25	0.26, 3.67
Other	0	2	0.00	0.00, 1.71	2	0.00	0.00, 1.63
Melanoma	20	14	1.47	0.90, 2.27	14	1.42	0.87, 2.19
Mesothelioma	2	1	1.97	0.24, 7.11	1	1.89	0.23, 6.83
Multiple myeloma	3	1	2.21	0.46, 6.45	1	2.12	0.44, 6.18
NHL	1	5	0.21	0.01, 1.15	5	0.20	0.01, 1.11
Oesophagus	3	2	1.73	0.36, 5.06	2	1.66	0.34, 4.86
Oral cavity, pharynx & larynx	12	7	1.79	0.92, 3.12	7	1.72	0.89, 3.01
Head and neck	10	5	2.14	1.03, 3.94	5	2.07	0.99, 3.81
Larynx	2	2	0.97	0.12, 3.51	2	0.94	0.11, 3.39
Pancreas	0	2	0.00	0.00, 1.64	2	0.00	0.00, 1.57
Thyroid	0	1	0.00	0.00, 5.49	1	0.00	0.00, 5.30
Unknown	1	4	0.25	0.01, 1.38	4	0.24	0.01, 1.32

Table C.9: HMAS *Sydney*, Navy Vietnam veterans: Observed and expected number of cancers, and standardised incidence ratios (SIRs). Period examined: 1982–2000.

		Scenario 1 (excluding veterans whose status is unknown)			Scenario 2 (including veterans whose status is unknown)		
Cancer type	**Observed**	**Expected**	**SIR**	**95% CI**	**Expected**	**SIR**	**95% CI**
All cancers	241	202	1.20	1.04, 1.35	209	1.15	1.01, 1.30
Brain	7	5	1.42	0.57, 2.93	5	1.38	0.55, 2.84
Breast	1	0	2.42	0.06, 13.50	0	2.34	0.06, 13.04
Connective soft tissue	0	2	0.00	0.00, 1.89	2	0.00	0.00, 1.83
Eye	0	1	0.00	0.00, 4.49	1	0.00	0.00, 4.34
Gastrointestinal	39	35	1.12	0.77, 1.47	36	1.08	0.74, 1.42
Colorectal	29	28	1.02	0.65, 1.40	29	0.99	0.63, 1.35
Colon	13	16	0.80	0.42, 1.36	17	0.77	0.41, 1.32
Rectum	15	12	1.30	0.73, 2.15	12	1.26	0.70, 2.07
Stomach	8	6	1.39	0.62, 2.74	6	1.34	0.59, 2.65
Genitourinary	46	45	1.02	0.72, 1.31	47	0.98	0.70, 1.27
Bladder	8	8	1.05	0.47, 2.08	8	1.02	0.45, 2.00
Kidney	6	6	0.96	0.35, 2.09	6	0.93	0.34, 2.02
Prostate	25	26	0.97	0.59, 1.35	27	0.93	0.57, 1.30
Testis	7	4	1.61	0.65, 3.32	4	1.56	0.63, 3.22
Hodgkin's disease	2	2	1.31	0.16, 4.75	2	1.27	0.15, 4.60
Leukemia	9	6	1.58	0.72, 2.99	6	1.52	0.70, 2.89
Lymphoid leukemia	4	3	1.50	0.41, 3.85	3	1.45	0.40, 3.72
LL_acute	0	0	0.00	0.00, 8.62	0	0.00	0.00, 8.35
LL_chronic	4	2	2.19	0.60, 5.61	2	2.12	0.58, 5.42
Myeloid leukemia	5	3	1.81	0.59, 4.23	3	1.75	0.57, 4.09
ML_acute	3	1	2.02	0.42, 5.92	2	1.96	0.40, 5.72
ML_chronic	2	1	2.08	0.25, 7.51	1	2.01	0.24, 7.27
Liver	2	2	1.01	0.12, 3.65	2	0.98	0.12, 3.52
Lung	36	22	1.61	1.08, 2.14	23	1.55	1.05, 2.06
Adenocarcinoma	15	6	2.40	1.34, 3.96	6	2.31	1.30, 3.82
Squamous	7	6	1.15	0.46, 2.37	6	1.11	0.45, 2.29
Small-cell	4	3	1.20	0.33, 3.06	3	1.16	0.31, 2.96
Large-cell	3	4	0.85	0.18, 2.49	4	0.82	0.17, 2.41
Other	7	3	2.21	0.89, 4.55	3	2.13	0.86, 4.39
Melanoma	40	32	1.27	0.87, 1.66	33	1.22	0.84, 1.60
Mesothelioma	2	2	1.26	0.15, 4.56	2	1.22	0.15, 4.40
Multiple myeloma	0	2	0.00	0.00, 1.61	2	0.00	0.00, 1.55
NHL	7	10	0.70	0.28, 1.45	10	0.68	0.27, 1.40
Oesophagus	3	3	1.07	0.22, 3.14	3	1.04	0.21, 3.03
Oral cavity, pharynx & larynx	15	12	1.30	0.73, 2.14	12	1.25	0.70, 2.06
Head and neck	11	8	1.31	0.65, 2.34	9	1.26	0.63, 2.26
Larynx	4	3	1.27	0.35, 3.25	3	1.22	0.33, 3.13
Pancreas	0	4	0.00	0.00, 1.01	4	0.00	0.00, 0.98
Thyroid	1	2	0.57	0.01, 3.20	2	0.56	0.01, 3.10
Unknown	12	7	1.80	0.93, 3.14	7	1.74	0.90, 3.03

Table C.10: HMA Ships *Brisbane, Hobart* and *Perth*, Navy Vietnam veterans: Observed and expected number of cancers, and standardised incidence ratios (SIRs). Period examined: 1982-2000.

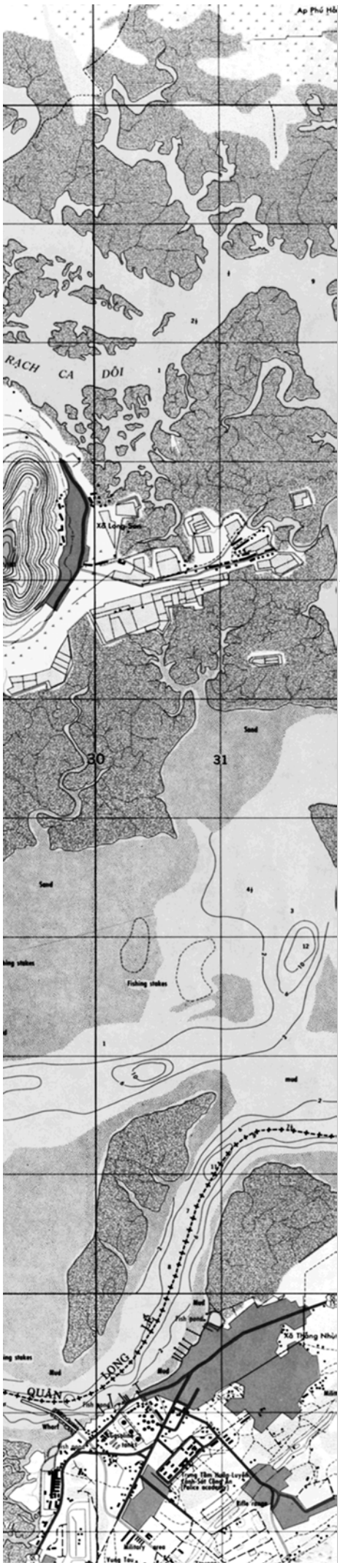
		Scenario 1 (excluding veterans whose status is unknown)			Scenario 2 (including veterans whose status is unknown)		
Cancer type	**Observed**	**Expected**	**SIR**	**95% CI**	**Expected**	**SIR**	**95% CI**
All cancers	74	67	1.11	0.86, 1.36	68	1.09	0.84, 1.33
Brain	0	2	0.00	0.00, 2.32	2	0.00	0.00, 2.27
Breast	0	0	0.00	0.00, 27.49	0	0.00	0.00, 26.93
Connective soft tissue	2	1	3.21	0.39, 11.60	1	3.14	0.38, 11.36
Eye	0	0	0.00	0.00, 13.86	0	0.00	0.00, 13.57
Gastrointestinal	9	12	0.76	0.35, 1.45	12	0.75	0.34, 1.42
Colorectal	6	10	0.62	0.23, 1.35	10	0.61	0.22, 1.32
Colon	3	6	0.54	0.11, 1.58	6	0.53	0.11, 1.55
Rectum	3	4	0.76	0.16, 2.22	4	0.74	0.15, 2.17
Stomach	3	2	1.56	0.32, 4.57	2	1.53	0.32, 4.48
Genitourinary	20	15	1.33	0.82, 2.06	15	1.31	0.80, 2.02
Bladder	1	3	0.40	0.01, 2.20	3	0.39	0.01, 2.16
Kidney	5	2	2.36	0.77, 5.51	2	2.31	0.75, 5.40
Prostate	13	9	1.49	0.79, 2.55	9	1.46	0.78, 2.50
Testis	1	1	0.83	0.02, 4.65	1	0.81	0.02, 4.54
Hodgkin's disease	0	0	0.00	0.00, 8.19	0	0.00	0.00, 8.01
Leukemia	0	2	0.00	0.00, 1.98	2	0.00	0.00, 1.94
Lymphoid leukemia	0	1	0.00	0.00, 4.15	1	0.00	0.00, 4.07
LL_acute	0	0	0.00	0.00, 28.73	0	0.00	0.00, 28.09
LL_chronic	0	1	0.00	0.00, 5.94	1	0.00	0.00, 5.82
Myeloid leukemia	0	1	0.00	0.00, 4.16	1	0.00	0.00, 4.07
ML_acute	0	0	0.00	0.00, 7.66	0	0.00	0.00, 7.50
ML_chronic	0	0	0.00	0.00, 12.14	0	0.00	0.00, 11.90
Liver	0	1	0.00	0.00, 5.62	1	0.00	0.00, 5.50
Lung	12	8	1.59	0.82, 2.79	8	1.56	0.81, 2.73
Adenocarcinoma	5	2	2.34	0.76, 5.46	2	2.29	0.74, 5.36
Squamous	3	2	1.49	0.31, 4.34	2	1.46	0.30, 4.26
Small-cell	1	1	0.88	0.02, 4.89	1	0.86	0.02, 4.79
Large-cell	3	1	2.51	0.52, 7.34	1	2.46	0.51, 7.19
Other	0	1	0.00	0.00, 3.57	1	0.00	0.00, 3.50
Melanoma	13	10	1.28	0.68, 2.19	10	1.25	0.67, 2.14
Mesothelioma	1	1	1.81	0.05, 10.11	1	1.78	0.04, 9.90
Multiple myeloma	0	1	0.00	0.00, 4.75	1	0.00	0.00, 4.65
NHL	4	3	1.23	0.33, 3.14	3	1.20	0.33, 3.08
Oesophagus	1	1	1.06	0.03, 5.90	1	1.04	0.03, 5.78
Oral cavity, pharynx & larynx	6	4	1.51	0.56, 3.29	4	1.48	0.54, 3.23
Head and neck	4	3	1.40	0.38, 3.57	3	1.37	0.37, 3.50
Larynx	2	1	1.82	0.22, 6.58	1	1.79	0.22, 6.45
Pancreas	2	1	1.64	0.20, 5.91	1	1.60	0.19, 5.79
Thyroid	0	1	0.00	0.00, 6.78	1	0.00	0.00, 6.63
Unknown	0	2	0.00	0.00, 1.67	2	0.00	0.00, 1.64

Table C.11: Navy Vietnam veterans, ≤ 30 days in Vietnamese waters: Observed and expected number of cancers, and standardised incidence ratios (SIRs). Period examined: 1982–2000.

		Scenario 1 (excluding veterans whose status is unknown)			Scenario 2 (including veterans whose status is unknown)		
Cancer type	**Observed**	**Expected**	**SIR**	**95% CI**	**Expected**	**SIR**	**95% CI**
All cancers	845	673	1.26	1.17, 1.34	696	1.21	1.13, 1.30
Brain	20	16	1.28	0.78, 1.98	16	1.24	0.76, 1.92
Breast	1	1	0.75	0.02, 4.15	1	0.72	0.02, 4.02
Connective soft tissue	4	6	0.65	0.18, 1.68	6	0.64	0.17, 1.63
Eye	2	3	0.76	0.09, 2.75	3	0.74	0.09, 2.67
Gastrointestinal	145	119	1.21	1.02, 1.41	124	1.17	0.98, 1.36
Colorectal	120	98	1.23	1.01, 1.45	101	1.19	0.97, 1.40
Colon	75	56	1.33	1.03, 1.64	58	1.29	1.00, 1.58
Rectum	43	40	1.08	0.76, 1.40	41	1.05	0.73, 1.36
Stomach	22	19	1.13	0.66, 1.60	20	1.09	0.64, 1.55
Genitourinary	173	155	1.12	0.95, 1.28	160	1.08	0.92, 1.24
Bladder	26	26	1.00	0.61, 1.38	27	0.96	0.59, 1.33
Kidney	24	21	1.15	0.69, 1.61	22	1.12	0.67, 1.56
Prostate	108	92	1.17	0.95, 1.40	96	1.13	0.92, 1.34
Testis	11	12	0.95	0.47, 1.70	12	0.92	0.46, 1.65
Hodgkin's disease	4	4	0.91	0.25, 2.33	5	0.88	0.24, 2.26
Leukemia	34	19	1.82	1.21, 2.43	19	1.76	1.17, 2.35
Lymphoid leukemia	14	9	1.58	0.86, 2.65	9	1.53	0.84, 2.57
LL_acute	1	1	0.80	0.02, 4.47	1	0.78	0.02, 4.34
LL_chronic	12	6	1.91	0.99, 3.34	6	1.85	0.95, 3.23
Myeloid leukemia	18	9	2.03	1.20, 3.21	9	1.97	1.17, 3.11
ML_acute	10	5	2.07	0.99, 3.80	5	2.00	0.96, 3.68
ML_chronic	8	3	2.66	1.18, 5.24	3	2.58	1.14, 5.08
Liver	8	7	1.21	0.54, 2.39	7	1.17	0.52, 2.31
Lung	106	78	1.35	1.10, 1.61	81	1.31	1.06, 1.56
Adenocarcinoma	42	22	1.93	1.34, 2.51	23	1.86	1.30, 2.42
Squamous	26	21	1.21	0.75, 1.68	22	1.17	0.72, 1.62
Small-cell	11	12	0.93	0.46, 1.66	12	0.90	0.45, 1.61
Large-cell	13	12	1.06	0.56, 1.81	13	1.02	0.55, 1.75
Other	14	11	1.28	0.70, 2.14	11	1.23	0.67, 2.06
Melanoma	130	99	1.32	1.09, 1.54	102	1.28	1.06, 1.50
Mesothelioma	8	6	1.44	0.64, 2.84	6	1.39	0.62, 2.74
Multiple myeloma	4	8	0.51	0.14, 1.31	8	0.49	0.13, 1.27
NHL	21	32	0.66	0.38, 0.94	33	0.64	0.36, 0.91
Oesophagus	12	10	1.25	0.65, 2.18	10	1.21	0.62, 2.11
Oral cavity, pharynx & larynx	61	39	1.55	1.16, 1.93	41	1.50	1.12, 1.87
Head and neck	44	28	1.55	1.09, 2.01	29	1.51	1.06, 1.95
Larynx	17	11	1.53	0.89, 2.45	11	1.48	0.86, 2.37
Pancreas	11	12	0.88	0.44, 1.58	13	0.85	0.43, 1.53
Thyroid	3	5	0.57	0.12, 1.67	5	0.55	0.11, 1.62
Unknown	36	23	1.59	1.07, 2.11	23	1.54	1.04, 2.04

Table C.12: Navy Vietnam veterans, > 30 days in Vietnamese waters: Observed and expected number of cancers, and standardised incidence ratios (SIRs). Period examined: 1982–2000.

		Scenario 1 (excluding veterans whose status is unknown)			Scenario 2 (including veterans whose status is unknown)		
Cancer type	**Observed**	**Expected**	**SIR**	**95% CI**	**Expected**	**SIR**	**95% CI**
All cancers	228	181	1.26	1.09, 1.42	185	1.23	1.07, 1.39
Brain	4	4	0.92	0.25, 2.35	4	0.90	0.25, 2.31
Breast	0	0	0.00	0.00, 10.25	0	0.00	0.00, 10.05
Connective soft tissue	2	2	1.18	0.14, 4.27	2	1.16	0.14, 4.19
Eye	0	1	0.00	0.00, 5.07	1	0.00	0.00, 4.97
Gastrointestinal	33	32	1.02	0.67, 1.37	33	1.01	0.66, 1.35
Colorectal	27	26	1.02	0.64, 1.41	27	1.00	0.63, 1.38
Colon	16	15	1.06	0.61, 1.72	15	1.04	0.60, 1.69
Rectum	11	11	1.02	0.51, 1.82	11	1.00	0.50, 1.79
Stomach	6	5	1.15	0.42, 2.50	5	1.13	0.41, 2.46
Genitourinary	53	40	1.31	0.96, 1.67	41	1.29	0.94, 1.63
Bladder	8	7	1.16	0.52, 2.29	7	1.14	0.51, 2.25
Kidney	10	6	1.72	0.83, 3.16	6	1.69	0.81, 3.11
Prostate	29	23	1.24	0.79, 1.69	24	1.21	0.77, 1.66
Testis	6	3	1.89	0.69, 4.11	3	1.85	0.68, 4.03
Hodgkin's disease	3	1	2.47	0.51, 7.21	1	2.42	0.50, 7.08
Leukemia	1	5	0.20	0.00, 1.10	5	0.19	0.00, 1.08
Lymphoid leukemia	0	2	0.00	0.00, 1.52	2	0.00	0.00, 1.50
LL_acute	0	0	0.00	0.00, 10.73	0	0.00	0.00, 10.53
LL_chronic	0	2	0.00	0.00, 2.18	2	0.00	0.00, 2.14
Myeloid leukemia	1	2	0.41	0.01, 2.30	2	0.41	0.01, 2.26
ML_acute	1	1	0.76	0.02, 4.23	1	0.74	0.02, 4.15
ML_chronic	0	1	0.00	0.00, 4.46	1	0.00	0.00, 4.38
Liver	0	2	0.00	0.00, 2.08	2	0.00	0.00, 2.04
Lung	35	20	1.72	1.15, 2.29	21	1.69	1.13, 2.25
Adenocarcinoma	10	6	1.73	0.83, 3.17	6	1.69	0.81, 3.11
Squamous	9	5	1.67	0.76, 3.16	5	1.64	0.75, 3.11
Small-cell	4	3	1.29	0.35, 3.30	3	1.27	0.35, 3.24
Large-cell	10	3	3.07	1.47, 5.64	3	3.01	1.44, 5.54
Other	2	3	0.72	0.09, 2.60	3	0.71	0.09, 2.55
Melanoma	43	28	1.55	1.09, 2.01	28	1.52	1.07, 1.98
Mesothelioma	4	2	2.64	0.72, 6.76	2	2.59	0.71, 6.63
Multiple myeloma	0	2	0.00	0.00, 1.73	2	0.00	0.00, 1.70
NHL	10	9	1.12	0.54, 2.06	9	1.10	0.53, 2.02
Oesophagus	7	3	2.72	1.09, 5.61	3	2.67	1.07, 5.50
Oral cavity, pharynx & larynx	16	11	1.47	0.84, 2.39	11	1.45	0.83, 2.35
Head and neck	12	8	1.53	0.79, 2.66	8	1.50	0.77, 2.62
Larynx	4	3	1.33	0.36, 3.42	3	1.31	0.36, 3.35
Pancreas	3	3	0.90	0.19, 2.63	3	0.88	0.18, 2.58
Thyroid	0	1	0.00	0.00, 2.51	2	0.00	0.00, 2.46
Unknown	5	6	0.84	0.27, 1.95	6	0.82	0.27, 1.91



Consultative Forum

Appendix D - Consultative Forum

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

Membership

Mr Geoff Trevor-Hunt OAM
Vietnam Veterans Association of Australia

Mr Tim McCombe OAM
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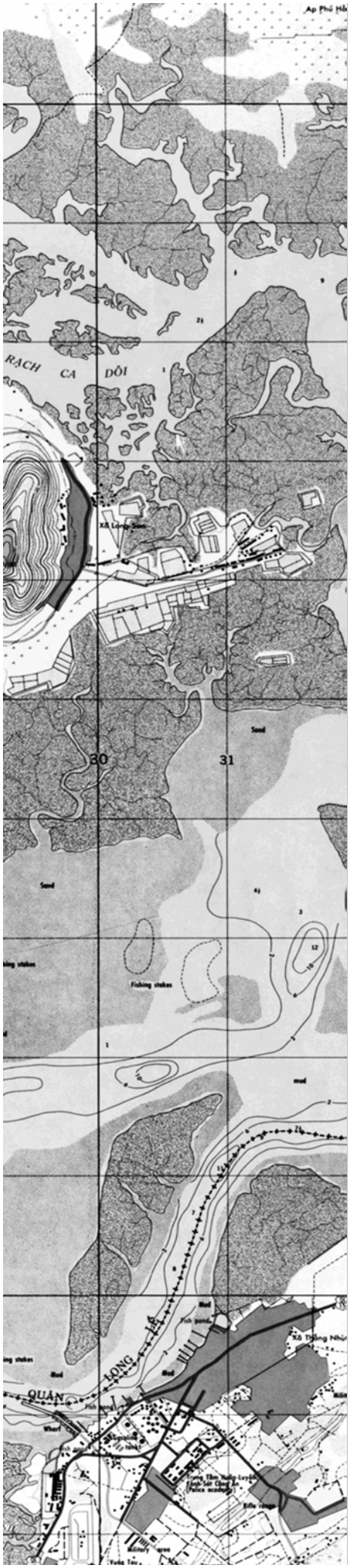
Mr John King
Returned & Services League of Australia Limited

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 E - Scientific Advisory Committee

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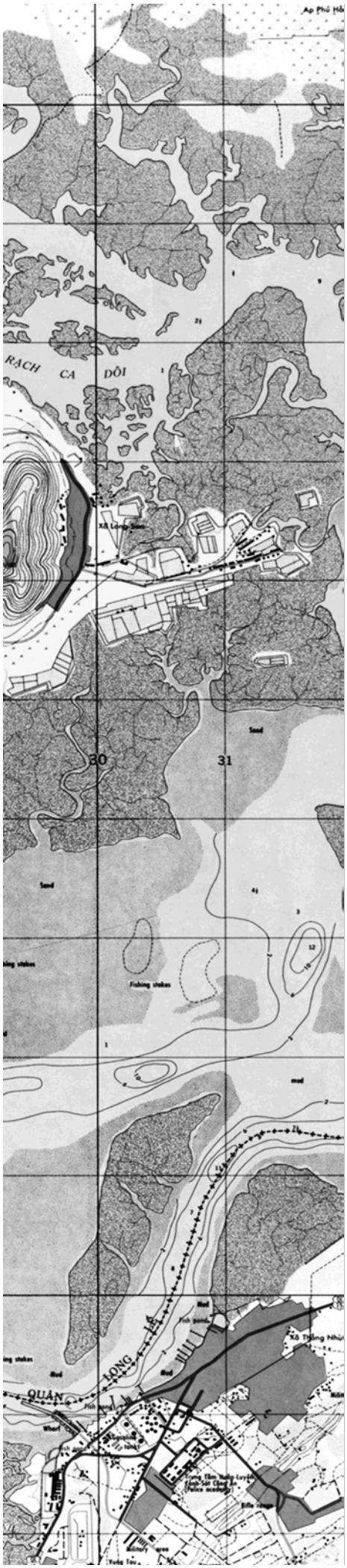

Project Team

Appendix F - Project Team

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