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Department of Veterans' Affairs
Australian Institute of Health and Welfare

Australian National Service Vietnam Veterans:

Mortality and Cancer Incidence

2005

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The Hon Bruce Billson, MP
Minister for Veterans' Affairs
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Dear Minister

I have pleasure in submitting to you the final report of the *Australian National Service Vietnam Veterans: Mortality and Cancer Incidence* study. This study investigated mortality and cancer incidence in National Service veterans who served in Vietnam compared with National Service personnel who did not serve in Vietnam.

This report is the third of four volumes to be published in this series on Vietnam veterans. The first volume was a cancer incidence study of Vietnam veterans, and the second volume extended the previous mortality study of Vietnam veterans which was published in 1997. The fourth volume will extend the 1992 Dapsone study. Taken together, these reports present a comprehensive picture of mortality and cancer incidence in Vietnam veterans.

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 Mortality report.

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

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

Yours sincerely

Simon Harrington
COMMISSIONER

13 April 2006

THE UNIVERSITY OF
NEW SOUTH WALES

13 April 2006

Rear Admiral Simon Harrington AM
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PROFESSOR
PETER SMITH
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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 third volume of the current series of studies – *Australian National Service Vietnam Veterans: Mortality and Cancer Incidence 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 the National Service group, compared to Australian community norms, showed reduced mortality as a consequence of the "healthy worker" effect. However direct comparison of veterans to non veterans showed increased mortality and cancer incidence for the veterans group.

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 final report 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
CARO	Central Army Records Office
CI	Confidence Interval
CMF	Civilian Military Force
CNS	Central nervous system
COD	Cause of Death
COPD	Chronic obstructive pulmonary disease
DIMIA	Australian Government Department of Immigration, Migration and Indigenous Affairs
DOD	Australian Government Department of Defence
DVA	Australian Government Department of Veterans' Affairs
HWE	Healthy worker effect
HIC	Health Insurance Commission
ICD	International Classification of Disease
MVA	Motor vehicle accident
NAA	National Archives of Australia
NAS	National Academy of Science
NCSCH	National Cancer Statistics Clearing House
NDI	National Death Index
NHL	Non-Hodgkin's lymphoma
NRVV	Nominal Roll of Vietnam Veterans
NYSIIS	New York State Intelligence Information System
PTSD	Post-traumatic stress disorder
RAAF	Royal Australian Air Force
RAN	Royal Australian Navy
RAR	Royal Australian Regiment
RBDM	Registrars of Birth Deaths and Marriage
RN	Royal Navy (British)
RNZN	Royal New Zealand Navy
RR	Relative Rate
SD	Standard deviation
SIR	Standardised Incidence Ratio
SMR	Standardised Mortality Ratio
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.

National Service veteran: For the purposes of this study a National Service veteran is a man who was conscripted for Army service under the National Service scheme between January 1965 and December 1972 and who had service in Vietnam.

National Service non-veteran: For the purposes of this study a National Service non-veteran is a man who was conscripted for Army service under the National Service scheme between January 1965 and December 1972 and served in the Army but did not have service in Vietnam.

Soldiers climb aboard a bridgelaying tank in Phuoc Tuy Province. *[FAI/70/0366/VN]*

Troops work to free a 105mm Howitzer from the mud in Phuoc Tuy Province. *[COL/67/0548/VN]*

A muzzle blast from an 81mm mortar during night firing at Fire Support Base Peggy. *[FAI/70/0168/VN]*

Troops wait for helicopters along Kapyong Helipad at Nui Dat. *[CAM/68/0002/VN]*

Troops move towards the Long Hai hills. *[BRN/68/0261/VN]*

Members of the ANZAC Battalion fill drink bottles at an underground well. *[CAM/67/1067/VN]*

Soldiers prepare to eat some rations after the Battle of Long Tan. *[FOR/66/0671/VN]*

A soldier crosses a fast flowing jungle stream in Phuoc Tuy Province. *[BUL/68/0928/VN]*

Soldiers install a water system for a village in Phuoc Tuy Province. *[COM/69/0005/VN]*

An Armoured Personnel Carrier advances through open country. *[WAR/70/0053/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 third of four volumes published in this study on Vietnam veterans. The other volumes are:

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

Study objectives

The objectives of the National Service study were to:

- identify all deaths among the male Australian National Service Vietnam era cohort from the time of completing service to 31 December 2001;
- identify all cancers diagnosed among the male Australian National Service cohort from 1982 to 31 December 2000;
- compare mortality and cancer incidence among the National Service cohort with the expected mortality and cancer incidence of the Australian community; and
- compare mortality and cancer incidence of National Servicemen who went to Vietnam to that of National Servicemen who served only in Australia.

Study design

This study was a retrospective cohort study of male National Service personnel who served in the Vietnam era between 1966 and July 1973. The study examined all deaths identified from the end of service to 31 December 2001 and all cancers diagnosed from 1982 to 31 December 2000. Relative mortality and cancer incidence rates were calculated for National Servicemen who served in Vietnam compared to those National Service personnel who served only in Australia during the Vietnam era. Standardised ratios comparing the National Service cohort to the Australian population were also calculated.

Report structure

Chapter One of the report provides a brief background to the Vietnam War and the National Service scheme. **Chapter Two** details the methods used for this study. In brief, the study roll of National Servicemen was matched to a number of databases to determine vital status, the number of deaths and their causes and the number and types of cancers diagnosed. The mortality and cancer incidence experience of National Servicemen who went to Vietnam was compared to that of those that served in Australia. Comparison of mortality and cancer incidence for both groups was also made to the Australian population.

Chapter Three presents the results of the analysis and the findings are discussed in **Chapter Four**.

Features of the study

A great strength of this study is that it controls for the healthy worker or healthy soldier effect. The study compares mortality and cancer incidence among National Servicemen with and without service in Vietnam. The two populations appear to have been very similar at the time of recruitment. Hence any differences in their mortality or cancer incidence are likely to be related to whether or not they went to Vietnam. The study approximates a natural experiment with individuals assigned to service in Vietnam essentially at random. Both groups were composed of equally healthy, fit soldiers who at the time of entry into the study differed essentially only by their Vietnam service.

The study does, however, have some limitations. It does not have information about individual exposure to specific chemical or environmental hazards, either at

the time of military service or subsequently. Variations in the nature of deployment or subsequent lifestyle or events for an individual are not known.

A second limitation is that there were no good measures of dose. Although information regarding time in Vietnam was available for the veteran group, this was not necessarily indicative of intensity of experience.

Furthermore, the Servicemen in the study cohort were generally middle aged by the end of the study (the majority was under 56 years old). As such, there are diseases of old age such as prostate cancer or degenerative mental disorders such as dementia, where few cases or deaths would be expected and meaningful observations on these conditions cannot be made.

Findings

This report presents the results of both indirect and direct comparison of mortality and cancer incidence. The indirect comparison analysis compares the mortality and cancer incidence of National Service veterans and non-veterans to the Australian community norms. The direct comparison analysis compares the rate of mortality and cancer incidence among National Service veterans to National Service non-veterans. This direct comparison examines the Vietnam effect and controls for the healthy worker effect.

Direct comparison of National Service veterans to non-veterans

- National Service veterans experienced a 23% higher overall mortality than non-veterans, RR = 1.23 (95% CI 1.13, 1.34).

- Mortality from digestive system diseases (primarily alcoholic liver disease) was more than double that observed in non-veterans.

- Deaths from motor vehicle accidents and suicide were significantly elevated among veterans by 31% and 43%, respectively.

- Mortality from mental disorders and neoplasms was also elevated among veterans, but of borderline statistical significance, RR = 2.75 (95% CI 0.98, 8.83) and
  RR = 1.16 (95% CI 0.98, 1.36), respectively.

- National Service veterans had a significant 14% elevation in their rate of cancer incidence compared to non-veterans, RR = 1.14 (95% CI 1.04, 1.26).

- National Service veterans experienced more than double the incidence of lung cancer, RR= 2.35 (95% CI 1.60, 3.49), head and neck cancer, RR = 2.02 (95% CI 1.23, 3.37) and cancer of the pancreas, RR = 2.46 (95% CI 1.04, 6.27).

- Lung cancer mortality was 79% higher than expected, RR = 1.79 (95% CI 1.22, 2.65) and death from cancer of pancreas was more than three times higher than expected, RR = 3.13 (95% CI 1.31, 8.26).

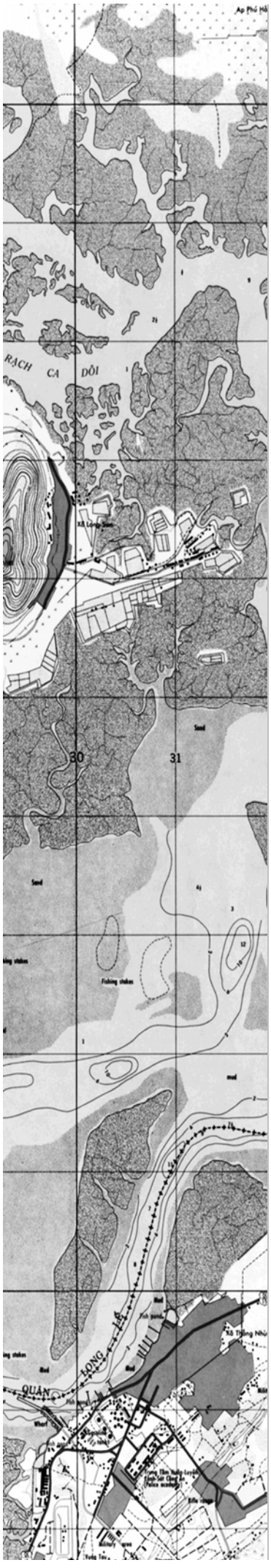
- There were no causes of death analysed for which National Servicemen who served in Vietnam had a statistically significant lower mortality rate than National Servicemen who did not serve in Vietnam. Furthermore, no specific cancer investigated had a statistically significant lower than expected incidence or mortality among veterans compared to non-veterans.

Indirect comparison to the Australian community norms

This study has shown that National Servicemen of the Vietnam War era exhibit a strong healthy worker effect. Overall mortality was 27% lower than expected, 19% lower for those that served in Vietnam and 33% lower for those who did not serve in Vietnam. For the over 60 specific causes of mortality investigated, no cause of death was significantly more common than expected within the Australian community and many were significantly less common than expected.

Summary and Conclusion

Taken together, the results showed that due to the healthy worker effect, National Servicemen as a group had lower mortality and cancer incidence rates than the general population. However, veterans who served in Vietnam experienced a higher than expected mortality and cancer incidence compared to their colleagues who did not serve in Vietnam. Specific causes of death that contributed to the higher than expected mortality include death from diseases of the digestive system (primarily liver diseases), lung and pancreatic cancer and death from external causes such as suicide and motor vehicle accidents. The incidence of lung, pancreatic and head and neck cancers was also higher than expected.



1

Introduction

Chapter 1 Introduction

This is a study of Vietnam War era National Servicemen who did and did not serve in Vietnam. The aim of this study is to attempt to control for the healthy worker effect, by comparing the mortality and cancer incidence of those who served in Vietnam to those who served in Australia, but who underwent a similar selection process.

This report is the third of four volumes to be published in this series of studies of Vietnam veterans. The first volume was a cancer incidence study of all military Vietnam veterans from the three Service branches. The second volume was a mortality study of the same total cohort. The fourth volume investigates the effect of exposure to the anti-malarial drug, Dapsone, on mortality and cancer incidence among the Army cohort.

1.1 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 and to give an overview of the National Service scheme during the Vietnam War era.

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.

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. Other Navy vessels escorted the troop carrier on these occasions.

The period 1966 to 1967 has been described as a period of consolidation. 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.

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 Australia 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.

1.2 National Service Scheme

This section provides some background information about the National Service system that operated in Australia during the Vietnam War and the processes that were used to select men for national service. It also describes the way the army allocated servicemen to army corps and units, and later selected them for service in Vietnam. Knowledge about these processes is important because it may help to identify whether there were any biases involved that might have affected the comparison between veteran and non-veteran servicemen. It will also help to understand why the non-veteran national servicemen are a suitable group with which to compare the veterans.

1.2.1 National service conscription

On 10 November 1964, the Australian government announced the reintroduction of compulsory military service because its commitments to the defence of Southeast Asia could not be matched by its military capacity[2]. Previous attempts to attract sufficient volunteers into the army during a period of relative low unemployment in Australia were not successful. Moreover, by introducing conscription, the government was able to draw on a more educated and skilled section of the work force than it was currently attracting.

Although announced as a 'reintroduction', the new National Service scheme, which came into effect on 24 November 1964 was quite different from its predecessor, which had operated from 1951 to 1959. The old scheme had originally been based on a universal compulsory military service obligation (abolished in favour of a selective service obligation in 1956) and had involved four (later reduced to three) months of full-time service in any of the three services followed by service in the reserve. Those who completed their obligation in the Army – by far the vast majority – could not be sent outside Australia (RAN and RAAF conscripts were often required to agree to serve outside Australia as a pre-condition of their being accepted into either service). By contrast, the new National Service scheme was based on a selective compulsory military service obligation from the outset. It provided for two years of full-time duty

with the Army (neither the RAN nor RAAF were involved with the new scheme), although in October 1971 the period of service was reduced to eighteen months. `

Under the scheme, all "British subjects" aged twenty years and normally resident in Australia were required to register, with the exception of Aboriginals and Torres Strait Islanders, non-naturalised migrants, employees of a foreign government or members of the permanent military forces. The exemption in regard to non-naturalised migrants proved to be highly unpopular, and in the face of mounting public pressure over the issue the Holt government responded by amending the legislation in August 1966. From 1 January 1967 onwards non-naturalised migrants (redefined as resident aliens in the amended legislation) were also made liable for National Service.

There were two registration periods a year: In January, for those turning twenty in the first half of the year; and in July for those whose twentieth birthday occurred in the second half. Each registration period was followed by a separate ballot to select the birth date of those required to enlist. The ballot system consisted of marbles placed in a barrel which was then spun. Following this, the required number of marbles, each representing a different birth date, was drawn by hand. The scheme operated from January 1965 to December 1972, when the newly elected Whitlam Government announced its abolition.[3]

An option was provided whereby those aged 18 years and nine months who wished to volunteer for National Service ahead of the normal schedule for registration and call-up could do so. While those who took this option still had to serve two years it did allow an individual to "get it out of the way" up to twelve months earlier than his peers. And while it guaranteed that an individual would see full-time military service, it still represented a shorter period of such service than the minimum three-year term of engagement offered to volunteers enlisting in the Regular Army. Nonetheless most candidates for National Service appear to have preferred to take their chances with the ballot.

As an alternative to full-time duty, those who joined the Citizen Military Forces (CMF) before their age group was balloted were exempt from call-up but were required to serve six years in the CMF. In cases where people had chosen this option, but left the CMF before the completion of the six years, they were called up automatically for two years service in the regular army.

Between January 1965 and December 1972 804,286 men registered for National Service; of these, 567, 238 were not selected by ballot and granted indefinite deferment. Of the remaining 237,048, a total of 99, 926 were rejected on medical, psychological or educational grounds; 35,000 were granted indefinite deferments on the grounds of marital circumstances or membership of the CMF; 32,027 were not immediately available for call-up as a result of either short-term deferments granted to students and apprentices or having failed other sections of the National Service Act. Another 5,500 were either serving, had served in the permanent forces, or were exempted from liability because they were theology students or were conscientious objectors. There were 63,735 men ultimately conscripted and of these, 19,450 went to Vietnam.[2]

1.3 Medical, psychological and educational assessment

Men who were selected for national service were assessed before they were enlisted into the army. They had to be fit for military service at enlistment, so men with life-shortening illnesses, serious congenital anomalies or behavioural disorders were excluded by the medical assessment and psychological screening process.

The assessment consisted of a medical examination, an interview and for those with education less than New South Wales intermediate level or equivalent, a set of army aptitude tests. The purpose of the assessment was to classify each person as:

- medically fit for all service duties; or
- apart from temporary circumstances, fit for all service duties; or
- not fit for all service duties.

The medical examination consisted of a medical history, physical examination, urinalysis (for albumin and sugar) and a chest x-ray. The doctors conducting the examination could classify a recruit as not fit for all service duties for any of the following reasons:

- cardiovascular disease, including systolic blood pressure outside 100-140mm Hg or diastolic blood pressure outside 60-90mm Hg;
- chronic diseases of the respiratory, genitourinary, alimentary, nervous, skeletal and/or haematopoietic systems;
- endocrine and metabolic disease;
- a history of malignancy;
- chronic diseases of skin, ear, nose, throat, eyes; and/or
- abnormalities of speech or dentition.

Men who did not meet the minimum educational standard were required to take psychological tests to screen out anyone with an IQ score of less than 80. The interview was designed to detect inconsistent scores on tests and obvious personality problems as well as identifying potential officer candidates. Men with long criminal records or who had committed major crimes were also rejected. Anyone classified as not fit for all service duties was ineligible to enlist.

The assessment for national service rejected many. Of those who were balloted in and not deferred or exempted, approximately 57% failed the medical examination. The 63,735 men (37%) who were passed as fit were conscripted into the Army. Eventually only 19,450 (11%) went to Vietnam while the remainder who were passed as fit served in Australia only.[2] As a result of the selection process, at the time of enlistment, national servicemen were fitter on average than other Australian men.

1.4 Selection for service in Vietnam

After completing 10 weeks basic training national servicemen were allocated to one of the 21 different corps in the army. This allocation determined what type of work the men carried out for the remainder of their national service. Within each corps servicemen were assigned to a specific profession, trade, job or function. The primary

determinant of allocation to a corps was the Army's manpower requirement plan that was based on the military capability the Army wanted in Vietnam. A number of other factors also influenced which corps individuals were allocated which included:

- suitability for particular trade training assessed by psychological tests; and
- any existing trade or professional qualifications; and
- meeting additional requirements prescribed by some corps; and
- the expressed preference of each man.

After they had completed about 3 months of specialist training in the corps, National Servicemen were posted to an operational unit. A unit was a group of servicemen who were regarded for administrative and operational purposes as a functional group. In this unit, National Servicemen were integrated with regular army soldiers and performed the normal duties of the unit as well as undertaking further training. Each unit belonged to one corps. However, while each unit in a corps was largely composed of servicemen of that corps, it might also have contained servicemen of other corps. This occurred because the units were required to function autonomously and therefore sometimes required the skills of servicemen from other corps. Units varied in size from around 800 men in an infantry battalion to possibly half a dozen in a specialist unit.

Selection of servicemen for Vietnam service was performed within corps. Corps were told of the specific manpower requirements of the Australian Force Vietnam. These requirements were based on the army's manpower requirement plan and specified the numbers and types of servicemen required. Even though methods of selection varied both between corps and within corps over time, generalisations can be drawn. For infantry and artillery, selection was based primarily upon whether a serviceman had been posted to a unit that was selected for Vietnam service according to operational need, since the majority of servicemen in these corps were replaced as a unit. For other corps, replacement was also by units until 1967, when replacement of servicemen in Vietnam changed to a trickle flow of individuals.

Infantry, armour, artillery and engineer units were in greater demand than others, therefore their personnel had a greater chance of being selected to serve in Vietnam than men from other corps. Manpower requirements were also influenced by the number of replacements and reinforcements required. Replacements were sent to Vietnam to replace servicemen whose 12 month tour of Vietnam or two-year national service obligation was completed. Reinforcements were sent to replenish units depleted by casualties resulting from illnesses and injuries.

Units that were nominated to go to Vietnam, went through an intensive training process before embarkation for Vietnam. During this time unit commanders removed soldiers deemed unsuitable in Vietnam. The effect of this selection may have emphasised the identification of unsuitable soldiers. Whereas in corps where replacement was by trickle flow, such as in the engineers, armour, ordnance, and service, selection may have concentrated on identifying those who were the most suitable soldiers. In addition, in all corps the personal characteristics of a serviceman, such as his training performance, medical fitness, months of residual army service, affected the likelihood of being deemed suitable for Vietnam service.

The process of allocating servicemen to corps and to units, and selecting units and servicemen for Vietnam service was the result of a complex interaction of many factors. Because of the complexity of these interactions the selection for service in Vietnam was not random and the possibility of bias in the selection of men for service in Vietnam cannot be excluded. If bias did occur, it was likely to occur when men were allocated to corps and units and not when they were selected for service in Vietnam since the majority went to Vietnam because their unit was nominated to go. A few who were selected for service in Vietnam were later excluded from going because they were medically unfit or had performed poorly during pre-embarkation training. However, even with these caveats, it would seem unlikely that the two groups were markedly dissimilar, other than the fact of their service in Vietnam.

1.5 Report structure

The next chapter of this report describes the methods used in determining mortality and cancer incidence amongst the National Service cohort. Chapter 3 describes some demographic characteristics of the National Servicemen and details the results of the mortality and cancer incidence analysis. Finally, Chapter 4 discusses the results in light of previous studies and the literature.

The literature review is reproduced in Appendix A. The protocol pertaining to this series of studies is in Appendix B. Appendix C provides tables of the results of the standardised analysis. Members of the study's Consultative Forum, Scientific Advisory Committee and the project staff are listed in Appendices D, E and F respectively.

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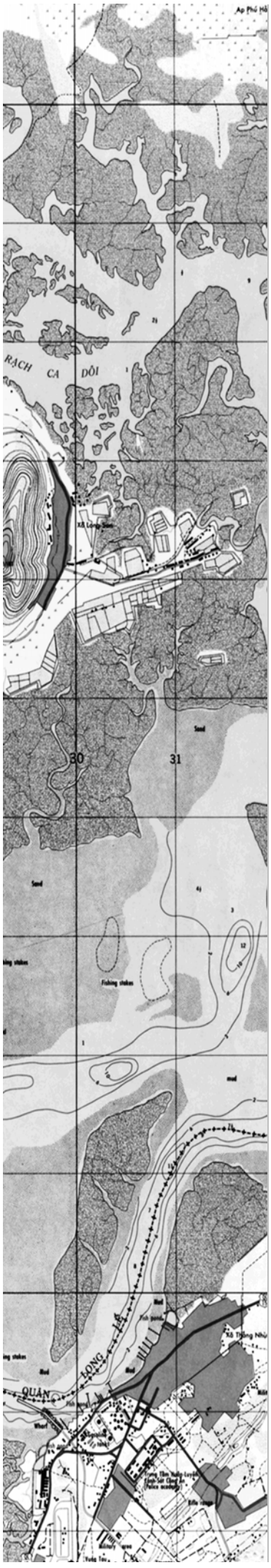

2

Methods

Chapter 2 Methods

In the conduct of a mortality and cancer incidence study such as this one, four tasks are of paramount importance: compiling the study roll, determining the vital status of as many participants as possible and investigating the cancer incidence and cause of death of all participants. This chapter will discuss data sources and methods used for determining the vital status, and methods for calculating mortality and cancer incidence.

Determining whether a veteran was 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 or who could have died.

A comparison between the mortality and the incidence of cancer of the National Servicemen who went to Vietnam and the National Servicemen who did not serve in Vietnam was carried out for a range of specific causes and groupings of causes of death and for the most common cancers in the Australian population. The mortality and cancer incidence of these two groups were also compared to the male Australian population.

2.1 Study Roll

The study roll for Vietnam War era National Servicemen was compiled from data used in previous studies.[1, 2] The present study roll includes 19,240 veterans and 24,729 non-veterans for a total of 43,969 in the National Servicemen cohort. In this study there were 291 more veterans than in the previous National Service study. The increase was due to improvements and amendments to the Nominal Roll of Vietnam Veterans since 1997. The number of non-veterans was 83 more than for the previous study. This difference is due to the inclusion of non-veterans who died prior to 1982 and the exclusion of those entries with insufficient personal details.

2.1.1 Quality of the Study Roll

The Study Roll contains details of 43,969 servicemen. Missing or incomplete data items reduced the chances of matching the Study Roll records with the NDI or other databases. Failure to match with the National Death Index (NDI) may falsely indicate that the serviceman is alive (false negative) or, conversely, an incorrect match may give the false impression that the serviceman is dead (false positive).

Table 2-1, 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 per cent 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 2-1: Frequencies of incomplete and missing data on the study roll

National servicemen	Total on Study roll	Initial only for first name	No second name	Missing date of birth
Veterans	19,240	0	1,800 (9.4%)	0
Non-veterans	24,729	0	2,384 (9.6%)	0

2.2 Vital status and sources of data

Determining vital status was carried out in part using computerised matching of national servicemen records with information in large national databases, such as the NDI, the electoral roll, Veterans' Affairs databases and other registers. Primarily, the study roll was matched against the 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 servicemen who died in Australia should be registered with the RBDM but the quality of information (eg. the lack of computerised records in the early years, changing names of servicemen, 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 servicemen.

Tables 2-2 and 2-3 summarise the different sources of vital status data used in this study. Table 2-2 shows the period covered for death information and Table 2-3 shows the sources used to determine events indicating whether a person is alive and on what date.

Table 2-2: **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	National Death Index
Since Vietnam service	Veterans' Affairs Client Data Base
After 1999	Health Insurance Commission Medicare database

Table 2-3: 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
Contracting 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

2.2.1 Department of Veterans' Affairs client data base

The Department of Veterans' Affairs (DVA) maintains its Client Data Base, which provides a central source of information about veterans who have registered 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 but records any subsequent service inconsistently.

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 Army service records office. However, service numbers, where recorded, provided confirmation of correct matches from other sources. It should be noted that pension related details were not accessed for the purposes of this study.

The Department of Veterans' Affairs has no information on the vital status of servicemen who have not registered for any benefit provided by the Department.

2.2.2 The National Death Index and the National Mortality Database

The NDI is a database located at the Australian Institute of Health and Welfare. It contains identified records of all deaths in Australia registered after 1980. In excess of 2.5 million records are contained in the database. The Registrars of Births, Deaths and Marriages in each Australian State and Territory supply 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. For identification of deaths prior to 1980 the individual registries were searched.

Although the NDI identifies each person who dies, it does not record the cause of death in a standardised manner. This standardised cause of death information is available in the National Mortality Database, also located at the Australian Institute of Health and Welfare.

The National Mortality Database contains de-identified information on each person's *underlying* cause of death, coded using the International Statistical Classification of Diseases, Injuries, and Causes of Death (ICD).[3] An NDI record can be linked to its corresponding record in the National Mortality Database, via a common registration number to obtain cause of death information, under Ethics Committee approval.

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 are provided in Section 2.3.1.

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 Registries of Births, Deaths and Marriages.

2.2.3 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 will 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: [4]

- 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 5 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.

2.2.4 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.[5]

Two databases are maintained by the Health Insurance Commission: 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.[5] The excess is because those enrolled in Medicare include some persons who are not Australian residents (eg. long-term visitors, greater than 6 months, and eligible short-term visitors).

Data quality

When notified, the Health Insurance Commission records the date of death and the date of departure from Australia of persons on its database, but more commonly the record just becomes 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.

2.2.5 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%.

2.2.6 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 serviceman, 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.

2.3 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.[6]

The software package[7] used for 'probabilistic matching' calculates the likelihood of a correct linkage, i.e. 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.

2.3.1 Matching by DVA

DVA was responsible for matching the Study Roll of national servicemen of the Vietnam War era with information indicative of vital status of servicemen 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 servicemen receiving payment of a pension or allowance from the DVA and records of client deaths. If there was a match, the serviceman was recorded as being alive at the date of last payment or if a death was recorded, the serviceman'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 servicemen's 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 serviceman was recorded as being alive.

2.3.2 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 and the NCSCH were undertaken using 'probabilistic' matching techniques.

Matching with the NDI and 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 servicemen's details.

The identification of the cause of death (COD) amongst servicemen was determined by matching the Study Roll against the deaths registrations at the Registries of Births, Deaths and Marriages (RBDM). This was achieved by matching with the NDI, which holds all the RBDM deaths from 1980, or by directly searching at the individual registries for deaths prior to 1980.

As well as vital status information, matching to the NCSCH and the Victorian cancer registry provided information on cancer diagnosis and date of diagnosis. 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 those was recorded on the NCSCH, and was included in the analysis.

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 BDM

It was considered likely that a significant proportion of the 'unknown' group (i.e. those servicemen who were not found on any of the above mentioned databases) may have been missed because they had died during the period from 1966, when the first servicemen 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. NSW, Victorian 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, which could then be further examined by the 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.

2.3.3 Matching by the HIC

The HIC was responsible for the following tasks:

- matching of servicemen 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 there was a more recent date of death or departure from Australia, was recorded.

2.3.4 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 servicemen 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.

2.4 Results of matching process

The summary results of matching are presented in Table 2-4. It shows that vital status was determined for 96.7% of the cohort and 3.3% were lost to follow-up.

Of the 3.3% lost to follow-up, 364 or 0.8% were partially unknown, that is, they were known to be alive until a specific time point during the study period but were lost to follow-up by the end of the study on 31 December 2001. In this study, the national servicemen who went to Vietnam had a lower proportion of subjects lost to follow-up compared with the non-veterans, 2.2% versus 4.1%.

Table 2-4: Summary of vital status as of 31 December 2001

Servicemen	Alive		Dead		Unknown		Total
Veterans	17,756	92.3%	1,052	5.5%	432	2.2%	19,240
Non-veterans	22,616	91.5%	1,089	4.4%	1,024	4.1%	24,729
All National servicemen	40,372	91.8%	2,141	4.9%	1,456	3.3%	43,969

2.5 Summary and discussion on data matching

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

The cohort was first matched with data held by Veterans' Affairs. This included data on deaths obtained from the Department of Defence and data on deaths and those alive, obtained from the Veterans' Affairs 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 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 servicemen 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 & Territory RBDMs.

Overall, 91.8 % of the cohort was determined to be alive and 4.9 % were accepted as having died. This left 3.3 % of the veteran cohort for whom vital status remained unknown at the end of the study period.

The 1,456 servicemen with an unknown vital status were not in contact with DVA after 31 December 2001, and were not found on the Australian Electoral Roll, the NDI or other databases accessed. For these servicemen, it was therefore not

possible to determine whether they were still alive and residing in Australia on 31 December 2001 or if they had died or moved permanently overseas.

This group is referred to as the 'servicemen whose vital status is unknown' or 'servicemen lost to follow-up' for the purposes of this study. However, some of these unknowns were found on databases with entries prior to 31 December 2001, indicating that they were alive for at least some time of the study period.

2.5.1 Potential reasons for unknown status

The group of 1,456 servicemen lost to follow-up will possibly contain subjects who died, most likely before 1 January 1980, the first date for data for 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 43,969 National Servicemen followed up after approximately 30 years, the vital status of 3.3 % remained unknown.

2.6 Statistical methods

This study used two methods to analyse the mortality and cancer incidence experience of the National Servicemen. A direct comparison between the veterans and the non-veterans was used to calculate Relative Rate (RR). An indirect comparison was also used in which the mortality and cancer incidence of the veterans and the non-veterans was compared to the male Australian population and is presented as Standardised Mortality or Incidence Ratios (SMR/SIR). The indirect comparison was the method used in the first two volumes of this series on Vietnam veteran health.

2.6.1 Population at risk

Servicemen became part of the population at risk if they were alive at the beginning of the study period (1 January 1982 for the cancer incidence study, the end of their National Service time for the mortality study). They contributed person-time until the study end date (31 December 2000 for the cancer incidence study, 31 December 2001 for the mortality study) 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 for the cancer incidence study, and 22 years to the mortality study.

The end date of their National Service time was not available for the servicemen who did not go to Vietnam. However, the vast majority of these servicemen started their National Service at age 20, and served 2 years, so the study assumed they became part of the population at risk for the mortality study when they turned 22.

The length of time each cohort member was alive during the period of observation 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=1,456) was too large to ignore and therefore needed to be accounted for in the analysis where the servicemen's cancer incidence and mortality rates were compared to the Australian population. This was managed by treating the unknown vital status of servicemen using two scenarios for the population at risk:

- Scenario 1 excludes servicemen whose status is unknown from the at-risk population. These servicemen are effectively treated as average compared to the other servicemen. If the mortality/cancer incidence rate among those lost to follow-up is substantially different, then the SMR/SIR calculated using this scenario may be an over or under-estimate of the true situation.
- Scenario 2 includes servicemen 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 period. The effect of including servicemen whose status is unknown is that the expected number of cancers/deaths may be over-estimated and thus the estimate of the SIR/SMR may be lower than the true situation. This is because the servicemen 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 Scenario 1 is shown except where the unknowns have a bearing on results when both population scenarios are presented.

2.6.2 Direct comparison of National Servicemen

The direct comparison compares the sub-group of National Servicemen who went to Vietnam to the sub-group of National Servicemen who did not go to Vietnam. In this analysis the null hypothesis is that there is no difference between the two sub-groups, that is, that service in Vietnam had no effect on mortality or cancer incidence rates and consequently the rates should be the same in the two sub-groups.

The mortality/cancer incidence rates for the whole National Service group were used to determine the expected numbers of deaths/cancers in the sub-group that went to Vietnam and the sub-group that did not go to Vietnam. These were then compared to the observed numbers of deaths/cancer cases in the two sub-groups.

The direct comparison between the veterans and the non-veterans was carried out by dividing the ratio of (observed/expected) numbers of deaths/cases for the National Servicemen who went to Vietnam by that for the National Servicemen who did not go to Vietnam. This value is called the Relative Rate (RR).

A RR of 1.00 means that the mortality/cancer incidence rates are equal in the two subgroups. A RR of, say, 0.88 means that the rate in the first subgroup (in this study the veterans) is 0.88 times, or 12% less than that in the second subgroup (in this study the non-veterans), while a RR of 1.12 indicates an elevation of 12% in the incidence or death rate.

The relative rates are displayed in tables and visually in figures in this publication (see for example Figure 3-2). These figures have a vertical line showing the location of a RR of 1.0 indicating no difference in mortality or cancer incidence. Horizontal lines for individual cancers consist of a central dot showing the point estimate of the RR and a horizontal error bar showing the 95% confidence interval (CI). Small error bars indicate good precision. A result is statistically significant if the error bar does not cross the vertical 1.0 line. Error bars which are wholly to the right of the vertical line indicate causes of death/cancers that are significantly more common than expected and those wholly to the left of the vertical line indicate causes of death/cancers that are significantly less common than expected.

2.6.3 Indirect comparison with the male Australian population

The expected number of deaths/cases of cancer by cause of death/type of cancer was calculated for each year by applying five-year age-specific mortality/cancer incidence for the Australian male population to the corresponding age-specific number of living servicemen in each year.

The steps involved in these calculations were:

- Calculate incidence/mortality rates for the Australian male population for each cancer/cause of death being studied, by five-year age groups, for each year of the study period.
- Derive the population of living servicemen (population at risk) by 5-year age groups for the study period, from the National Servicemen Study Roll.
- Calculate the expected number of cases/deaths being studied for both groups of servicemen, had servicemen experienced the cancer incidence/mortality rates of the general Australian population for each year of the study period. This was done by multiplying the age-specific incidence rates for the Australian population by the corresponding servicemen population in that age group, for that year.

The yearly expected numbers of cases are added to derive the total expected number of cases for the study period. The actual number of cancers/deaths experienced by the servicemen (observed cases) was compared to the expected number, by dividing the former figure by the latter. The resulting ratio, the standardised incidence ratio (SIR) or the standardised mortality ratio (SMR), is above one if the number of observed cases among servicemen is higher than the expected number. The ratio is below one if the number of observed cases amongst servicemen is lower than the expected number.

Australian age-specific mortality rates for some CODs were not available for the whole study period. In these instances, study periods were reduced by advancing the starting year to when Australian mortality rates became available. The calculation of relative rates for the direct veteran/non-veteran comparison did not involve Australian mortality rates and the whole study period between 1963 and 2001 was used for all tabulated CODs.

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.

2.6.4 Confidence intervals

On their own, the RR/SIR/SMR are not sufficient to say whether the veterans experienced significantly higher or lower rates of cancer/mortality than might be expected because differences may arise by chance. The RR is the best estimate of the difference between the veterans and the non-veterans and the 95% CI gives an indication of the precision of that estimate. The SIR/SMR is the best estimate of the difference between the servicemen and the Australian population and the 95% confidence interval (CI) around the SIR/SMR gives an indication of the precision of that estimate. A narrow 95% CI indicates good precision, the true RR/SIR/SMR is likely to lie within a narrow range of values, while a wide 95% CI indicates poor precision.

A RR/SIR/SMR of 1.0 means that there is no difference between the two groups being compared. A 95% CI which does not include the value 1.0 indicates that the calculated RR/SIR/SMR is significantly different from 1.0 and, therefore, unlikely to be due to chance. In other words, there may be a real difference between the groups. For example, a RR 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.

A standard statistical assumption is that the observed number of cases has a Poisson distribution the mean of which is the expected number of cases. The Poisson assumption allows the closeness of the observed and expected numbers of cases to be assessed statistically. This study has calculated exact confidence levels[8] for the relative rates. Confidence intervals for the SIR/SMR were

calculated using the asymptotic method, except where the number of cancers diagnosed was small (<= 20), when the exact method was used.

2.6.5 Statistical Power

In addition to RR/SIR/SMR 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 an outcome of interest (ie. a specific cause of cancer incidence or mortality) 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 an event is very common or the difference between the groups is very large, then a smaller study will give a statistically significant result.

A study of this size, comprising nearly 44,000 National Servicemen, has 80% power to detect a statistically significant 20% difference between groups where the risk of cancer/mortality is approximately 2% or greater. This means that this study had good power to detect a 20% difference (RR = 1.2) for conditions such as all cause mortality or mortality due to cancer, but it had less power to detect a difference of this size for some other causes of death such as, for example, diseases of the respiratory or nervous system.

2.6.6 Adjustment for missing causes of death

Twenty-four servicemen (1.1 % of all national servicemen deaths) were known to have died but their cause of death was not recorded. This had no bearing on the all cause mortality analysis, but posed a problem for the cause-specific analysis. As there was no indication that these deaths were in any way different from those deaths with a known cause where documentation was available, these deaths were assigned a cause of death according to the distribution of causes of death among the other National Servicemen, adjusting for the year of death.

An additional 50 servicemen had poorly defined external causes of death. These deaths were allocated a more precise cause of death based on the distribution of the external causes of death among other National Servicemen, adjusting for the year of death. For example, most of these deaths involved major head trauma and the study estimated that 80% of these deaths were due to motor vehicle accidents.

These adjustments were only done for the comparison with the Australian male population; the direct comparison between the veterans and the non-veterans was based only on known causes of death.

2.7 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[9] Release 8.2. Tables of observed and expected cases of cancer and the standardised incidence ratio were compiled in EXCEL[10] 2003 and DeltaGraph[11] Version 5.0.1 was used to produce the graphs. Cohort characteristics were calculated using SPSS[12] statistical software.

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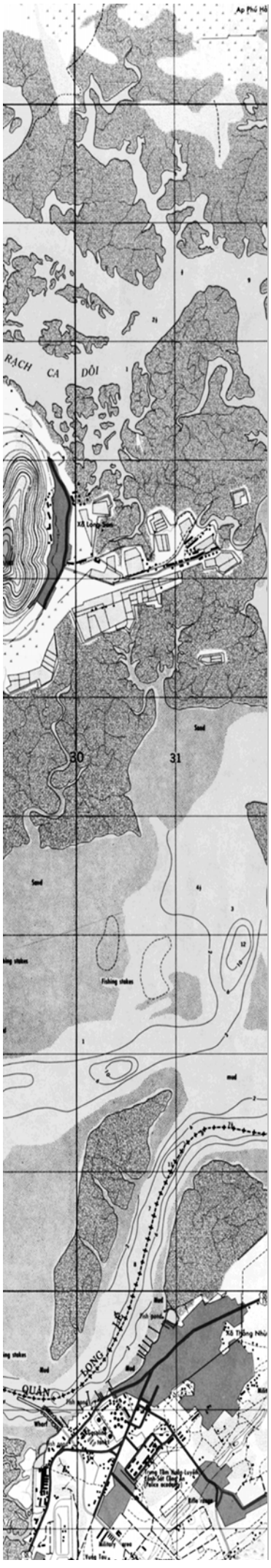


3

Results

Chapter 3 Results

This chapter describes some characteristics of the National Service veteran and non-veteran cohort. The age profile of the cohort is presented and some service details for National Service veterans.

The results of the mortality and cancer incidence analysis are presented. This report used two methods of analysis. The chapter first highlights the results of the indirect method, which compares the mortality and cancer incidence amongst National Servicemen to that expected for Australian males of the same age. These results are presented as Standardised Mortality Ratios (SMR) and Standardised Incidence Ratios (SIR). The chapter then details the results of the direct method, which compares mortality and cancer incidence amongst National Service veterans to that among National Service non-veterans and these are presented as Relative Rates (RR). Methods for these analyses are described in Chapter 2.

3.1 Cohort Characteristics

The National Service study cohort comprises 43,969 servicemen; 19,240 Vietnam veterans and 24,729 non-veterans. Information available for Vietnam veterans includes date of birth and age at service, duration of Vietnam service, number of tours and units served. For National Service non-veterans date of birth is available, but no service data.

3.1.1 Age of National Servicemen

As detailed in Chapter 1, conscription for Vietnam began in 1965 for all 20 year olds and selection was by ballot based on birthday. Although the majority of conscripts served for two years following conscription, service could be deferred and some conscripts were older when undertaking service. Selection for deployment to Vietnam was based on operational need and an individual conscript did not know if he would be deployed when he started service.

The majority of National Servicemen were born between 1945 and 1950. Thus veterans' age at the end of the mortality study period (2001) generally ranged from 51 to 56 years. The average age of National Service veterans at the end of the Vietnam conflict (for the purposes of this study 1 July 1973) was 26.3 ± 1.5 years whereas the average age of those who served in Australia was 26.1 ± 1.7 years.

Figure 3-1 shows the distribution of ages between National Service veterans and non-veterans. Although the average age of the two groups was similar, the distribution of ages was different with the oldest and youngest National Servicemen less likely to have served in Vietnam. The increase in spread is reflected in the larger standard deviation of 1.7 in the non-veterans as compared to 1.5 in the veterans. The excess numbers of low values would largely compensate the excess of very high values in the non-veterans, so the overall statistical impact of the difference between the distributions would be small.

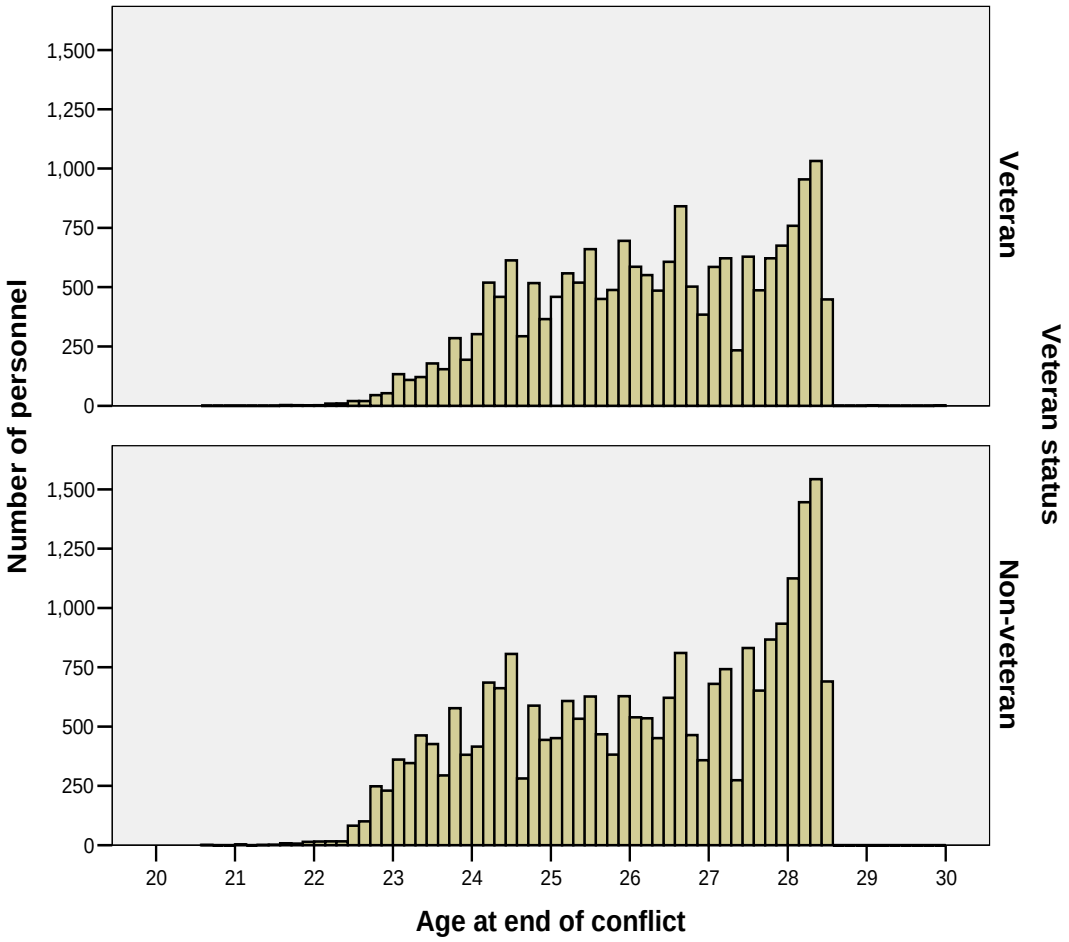


Figure 3-1: Age distribution for National Servicemen at the end of the Vietnam conflict

3.1.2 Characteristics of Vietnam service

Age at first service

Nearly 60% of National Service veterans were 21 years old at the start of their Vietnam service with 91% between 20 – 22 years. The age range for first service in Vietnam was 19 – 27 years.

Units and tours served

Three quarters of the veterans served in one unit and completed one tour of duty in Vietnam. However some veterans did as many as six to eight tours and served in up to five units.

National Service veterans served throughout the Army units deployed in Vietnam. Table 3-1 shows a selection of units for which approximately 2% or more of the cohort of National servicemen served. Data are for the first unit served in Vietnam. Many of those who were initially assigned to the 1 Australian Reinforcement Unit were then assigned to other units after arrival in Vietnam.

Table 3-1: Selected units served in Vietnam by National Service veterans

Unit	Number of National Servicemen	Percentage
HQ Australian Force Vietnam	402	2.1%
HQ 1 Australian Logistics Support Group	420	2.2%
HQ 1 Australian Task Force	603	3.1%
2 Advanced Ordnance Depot	420	2.2%
1 Australian Reinforcement Unit	2,333	12.1%
1 Field Regiment	447	2.3%
4 Field Regiment	445	2.3%
12 Field Regiment	478	2.5%
1 Field Squadron	850	4.4%
110 Signals Squadron	791	2.6%
17 Construction Squadron	1,004	5.2%
1 Battalion, Royal Australian Regiment	372	1.9%
2 Battalion, Royal Australian Regiment	757	3.9%
3 Battalion, Royal Australian Regiment	790	4.1%
4 Battalion, Royal Australian Regiment	644	3.3%
5 Battalion, Royal Australian Regiment	609	3.2%
6 Battalion, Royal Australian Regiment	577	3.0%
7 Battalion, Royal Australian Regiment	864	4.5%
8 Battalion, Royal Australian Regiment	398	2.1%
9 Battalion, Royal Australian Regiment	324	1.7%
Other units	5,712	29.7%

3.1.3 Time in Vietnam

Nearly half of National Service veterans served between 10 and 13 months in Vietnam. The average number of months served was 9.2 ± 3.1, with 98% of the veterans serving 13 months or less.

3.1.4 Summary of cohort characteristics

National Service veterans were young men serving throughout the many Army units during the Vietnam conflict. Three quarters of veterans served seven months or more in Vietnam. The National Service non-veterans who served in Australia were of a similar age, although the distribution of the age profile was different in that non-veterans had proportionally more older and younger men than the deployed group.

3.2 Mortality rates for National Service veterans and non-veterans

This section gives the results of the mortality analysis of National Service veterans and non-veterans.

There were 1,052 deaths recorded amongst the 19,240 National Service veterans and 1,089 deaths recorded amongst the 24,729 National Service non-veterans. The most common causes of death for both groups were external causes, neoplasms and diseases of the circulatory system.

3.2.1 Standardised mortality ratios for National Servicemen

First presented are the results of the indirect mortality analysis which details the comparison of the mortality experience of National Service veterans and non-veterans compared to the Australian male population. All results discussed in this sub-section are detailed in Appendix C, Tables C.1 to C.3, and presented as Standardised Mortality Ratios (SMR).

As a group, the Vietnam War era National Servicemen had a 27% lower than expected overall mortality between 1966 and 2001 compared to the Australian male population. All individual causes of death analysed were either significantly less common than expected or not significantly different from expectation with community norms.

Differences were observed between National Service veterans and non-veterans. Veterans displayed a 19% lower than expected overall mortality rate compared to the Australian male population. Specific causes of death that were significantly

less common than expected included mortality from diseases of the endocrine, nervous, circulatory and respiratory systems and external causes.

National service non-veterans exhibited a 33% lower than expected overall mortality compared to the Australian male population. Specific causes of death that were significantly less common than expected included mortality from diseases of the endocrine, nervous, circulatory, respiratory and digestive systems, neoplasms, infectious diseases and external causes.

In neither group were there any non-cancer causes of death for which National Service veterans or non-veterans had a significantly higher rate than expected compared to the Australian community.

3.2.2 Relative mortality rates for National Servicemen

The remainder of this section focuses on the relative mortality rates for National Service veterans compared to National Service non-veterans. As explained in Chapter 2, the relative rates are calculated by comparing the observed number of deaths in each group with the deaths that would have been expected assuming that both groups had experienced equal mortality rates. This analysis compares the mortality between two groups of men who were of similar age, health and fitness at the time of enlistment and who differ only by their Vietnam experience.

National Service veterans experienced a 23% higher overall mortality compared to non-veterans, RR = 1.23 (95% CI 1.13, 1.34). Mortality from digestive system diseases (primarily liver disease) was more than double that observed in non-veterans. Deaths from motor vehicle accidents and suicide were significantly elevated by 31% and 43%, respectively.

A result of note was a nearly five fold increase in relative rate from the rare motor neurone disease among veterans compared to non-veterans. This result was based on very small numbers (7 for veterans and 2 for non-veterans) and so did not reach statistical significance, RR = 4.73, (95% CI 0.90, 46.65). Mortality from mental disorders and neoplasms was also elevated, but of borderline statistical significance, RR = 2.75 (95% CI 0.98, 8.83) and RR = 1.16 (95% CI 0.98, 1.36), respectively. Specific neoplasms are discussed in Section 3.3.

Overall, mortality from diseases of the circulatory system did not significantly differ between the two National Service groups. However veterans tended to have proportionally higher mortality from ischaemic heart disease and lower mortality from cerebrovascular disease (stroke) compared to non-veterans.

There were no causes of death for which National Service veterans had a statistically significant lower mortality rate than National Servicemen who did not serve in Vietnam. Figure 3-2 and Table 3-2 present the results of the mortality analysis.

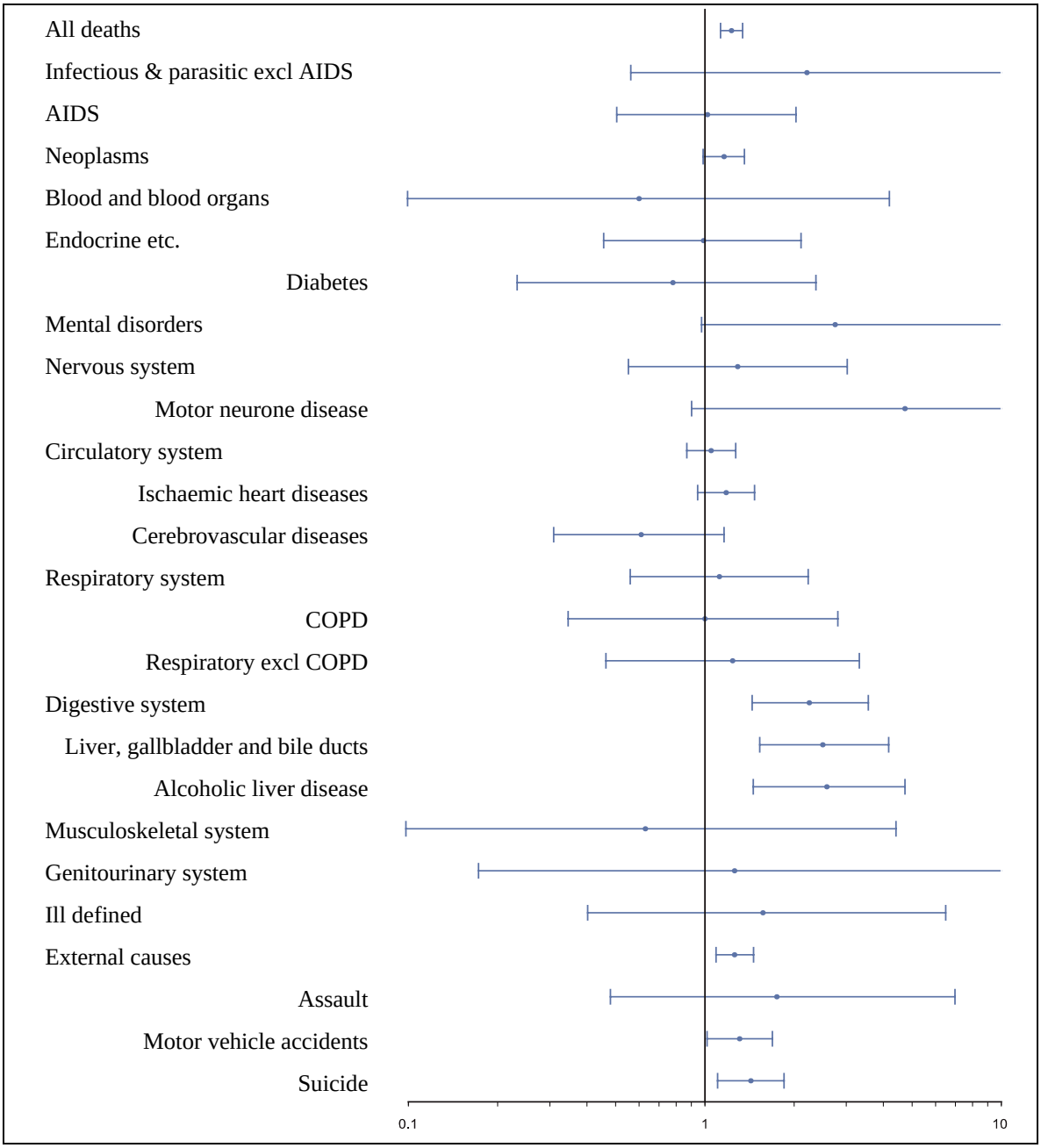


Figure 3-2: National servicemen mortality (1966 – 2001), relative rates and 95% CI.

Table 3-2: Observed and expected numbers of deaths (1966 – 2001) and the relative rates (RR) for National Service veterans and non-veterans

	Veterans		Non-veterans			
Cause of death	**Observed**	**Expected**	**Observed**	**Expected**	**RR**	**95% CI**
All deaths	1,052	941	1,089	1,200	1.23	1.13–1.34
Infectious and parasitic diseases excluding AIDS	7	5	4	6	2.21	0.56–10.29
AIDS	17	17	21	21	1.02	0.51–2.03
Tuberculosis	0	0	0	0	–	–
Neoplasms	290	268	320	342	1.16	0.98–1.36
Blood & blood organs	2	3	4	3	0.60	0.05–4.19
Endocrine, nutritional and metabolic diseases	14	14	18	18	0.99	0.46–2.11
Diabetes	6	7	10	9	0.78	0.23–2.37
Mental disorders	13	8	6	11	2.75	0.98–8.83
Nervous system	13	11	13	15	1.29	0.55–3.02
Multiple sclerosis	0	1	2	1	0.00	0.00–6.54
Motor neurone	7	4	2	5	4.73	0.90–46.65
Eye diseases	0	0	0	0	–	–
Ear diseases	0	0	0	0	–	–
Circulatory system	208	202	252	258	1.05	0.87–1.27
Ischaemic	159	145	172	186	1.18	0.94–1.47
Cerebrovascular	15	21	32	26	0.61	0.30–1.15
Respiratory system	18	17	20	21	1.12	0.56–2.23
Asbestosis	0	0	0	0	–	–
COPD	8	8	10	10	1.00	0.34–2.80
Respiratory excluding COPD	10	9	10	11	1.24	0.46–3.32
Digestive system	58	40	33	51	2.25	1.44–3.56
Liver, gall bladder and bile ducts	51	34	26	43	2.50	1.53–4.17
Alcoholic liver	39	26	19	32	2.58	1.46–4.73
Peptic ulcer	0	0	1	1	0.00	0.00–7.19
Skin and subcutaneous tissue	1	0	0	1	–	–
Musculoskeletal system	2	3	4	3	0.63	0.06–4.41
Genitourinary system	3	3	3	3	1.26	0.17–9.38
Congenital malformation	0	1	2	1	0.00	0.00–58.51
Ill defined	6	5	5	6	1.57	0.40–6.48
External causes	378	334	382	426	1.26	1.09–1.46
Assault	7	5	5	7	1.75	0.48–6.98
MVA	128	111	125	142	1.31	1.01–1.68
Suicide	129	107	115	137	1.43	1.10–1.85
Firearms	46	32	28	42	2.11	1.29–3.50
Gas and vapours	40	35	41	46	1.26	0.79–1.99
Hanging	25	19	18	24	1.72	0.90–3.35

3.3 Cancer incidence and mortality rates for National Servicemen

Cancer incidence and mortality were also investigated. Cancer incidence was investigated for the period 1982 to 2000 whereas cancer mortality data were available for the entire study period, 1966 to 2001.

During the period 1982 to 2000, 810 cancers were diagnosed amongst the 19,240 National Service veterans and 914 cancers were diagnosed amongst the 24,729 National Service non-veterans. During the entire study period there were 296 cancer deaths amongst National Service veterans and 320 cancer deaths amongst National Service non-veterans. The most common cancers diagnosed amongst Vietnam War era National Servicemen, veteran and non-veteran, were melanoma and cancers of the genitourinary and gastrointestinal systems.

3.3.1 Standardised cancer incidence and mortality rates for National Servicemen

The overall standardised cancer incidence rate for the National Service cohort was 4% lower than expected. However there were differences in cancer incidence between National Service veterans and non-veterans.

National Service veterans had significantly higher than expected incidence rates for melanoma and eye cancer compared to the Australian community and lower than expected rates for stomach cancer and NHL. Non-veterans had significantly lower than expected overall cancer incidence as well as lower than expected incidence for some individual cancers such as lung, liver, NHL and head and neck, but a higher than expected incidence for Hodgkin's disease. The incidence rates for all other cancer sites investigated were not significantly different from community norms or below expectation for both groups of National Servicemen (Appendix C, Tables C.4 to C.6).

Overall cancer mortality amongst all Vietnam War era National Servicemen was below expectation and all individual sites investigated did not differ significantly from community norms or were below expectation. There were, however, some differences between Vietnam veterans and non-veterans. Overall, National Service veterans displayed a cancer mortality rate that did not differ significantly from community norms but they exhibited significantly lower cancer mortality rates for melanoma and cancers of the genitourinary and gastrointestinal systems than the general population. All other sites investigated did not differ significantly from community norms. The most common causes of cancer death were cancers of the lung (68 deaths), gastrointestinal system (38 deaths) and brain and central nervous system (28 deaths).

National Service non-veterans also experienced significantly lower than expected overall cancer mortality and all cancer sites investigated showed mortality rates that did not differ significantly from community norms or were lower than

expected. The most common causes of cancer mortality were from cancers of the gastrointestinal system (58 deaths), lung (48 deaths) and leukaemia (23 deaths).

Standardised Mortality Ratios (SMR) are detailed in Appendix C, Tables C.7 to C.9.

3.3.2 Relative cancer incidence and mortality rates for National Servicemen

The relative incidence and mortality from all cancers and specific causes of cancer amongst National Service veterans and non-veterans were analysed. The results are presented in Figure 3-3 and Table 3-3 for cancer incidence, and Figure 3-4 and Table 3-4 for cancer mortality.

National Service veterans had a significant 14% elevation in their rate of cancer incidence compared to non-veterans, RR = 1.14 (95% CI 1.04, 1.26). This was reflected by a more than doubling in the incidence of lung cancer, head and neck cancer and cancer of the pancreas.

Specific histotypes of lung cancer were also analysed. Adenocarcinoma was the most common histotype of lung cancer and the veterans had more than twice the rate of non-veterans. The largest inequality, however, was for the squamous cell histotype, where the RR was nearly 5.

Cancer mortality amongst veterans was 16% higher than amongst non-veterans. However this result did not reach statistical significance, RR = 1.16 (95% CI 0.98, 1.36). Rates of two of the specific causes of cancer death analysed were significantly elevated. Lung cancer mortality was 79% higher than expected, RR = 1.79 (95% CI 1.22, 2.65) and death from cancer of pancreas was more than three times more common than expected, RR = 3.13 (95% CI 1.31, 8.26).

None of the analysed cancers had a statistically significant lower than expected incidence or mortality among veterans compared to non-veterans.

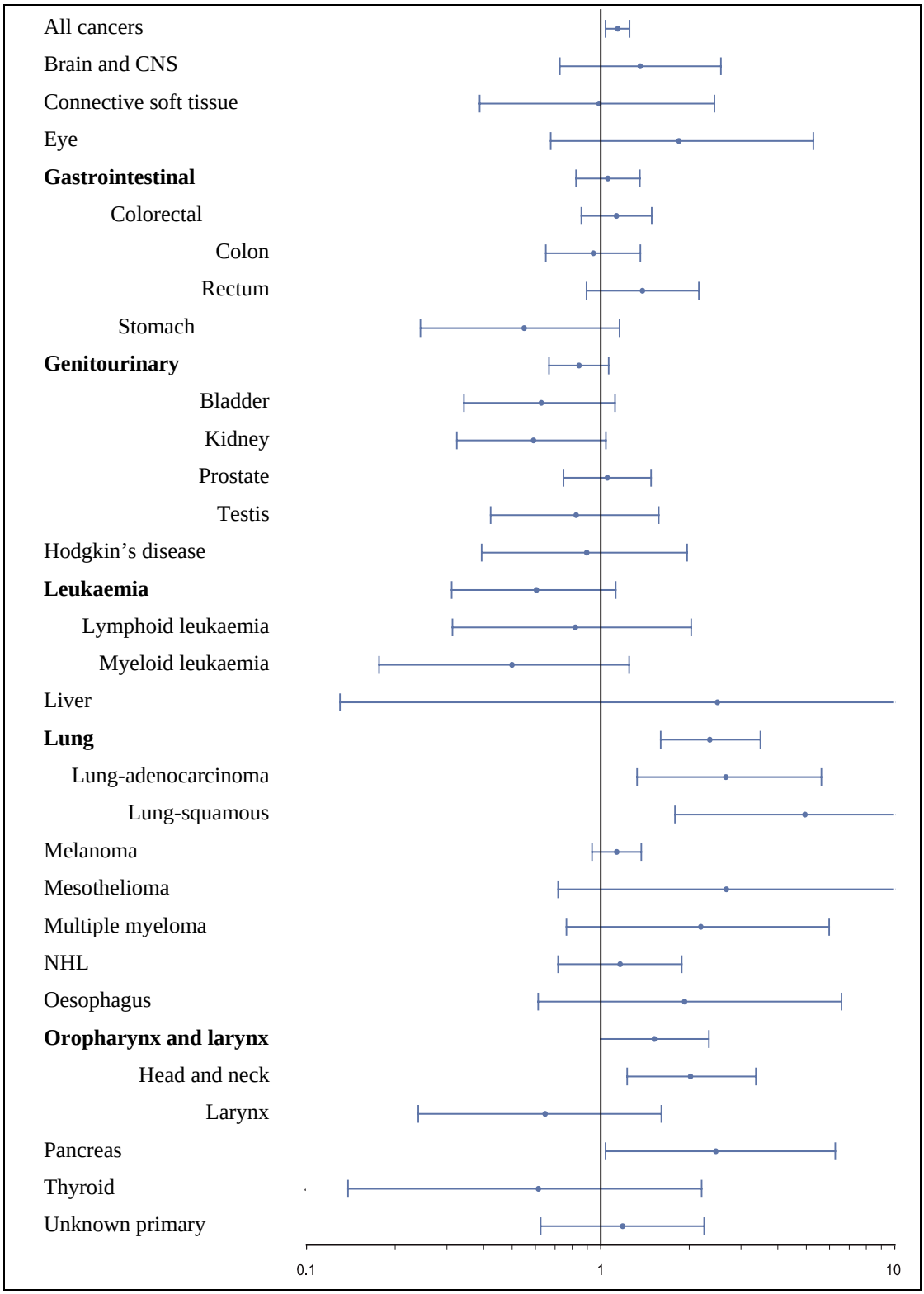


Figure 3-3: National servicemen cancer incidence (1982 – 2000), relative rates and 95% CI

Table 3-3: The observed and expected numbers of cancers diagnosed (1982 – 2000) and relative rates (RR) for National Service veterans and non-veterans

	Veterans		Non-veterans			
Cancer type	**Observed**	**Expected**	**Observed**	**Expected**	**RR**	**95% CI**
All cancers	810	753	914	971	1.14	1.04–1.26
Brain and CNS	23	20	22	25	1.36	0.73–2.56
Breast	0	1	2	1	0.00	0.00–7.64
Connective soft tissue	10	10	13	13	0.99	0.39–2.44
Eye	11	8	8	11	1.85	0.68–5.29
Gastrointestinal	121	117	145	149	1.06	0.82–1.36
Colorectal	103	96	116	123	1.13	0.86–1.49
Colon	54	56	72	70	0.94	0.65–1.36
Rectum	46	39	43	50	1.39	0.90–2.15
Stomach	11	16	25	20	0.55	0.24–1.16
Genitourinary	124	136	189	176	0.84	0.67–1.06
Bladder	19	25	39	33	0.63	0.34–1.11
Kidney	19	26	41	34	0.59	0.32–1.04
Prostate	65	63	79	81	1.05	0.75–1.48
Testis	17	19	27	25	0.83	0.42–1.57
Hodgkin's disease	12	13	18	17	0.90	0.39–1.97
Leukaemia	16	22	34	28	0.60	0.31–1.13
Lymphoid leukaemia	9	10	14	13	0.82	0.31–2.04
LL_acute	0	0	1	1	0.00	0.00–58.45
LL_chronic	8	9	11	10	0.90	0.31–2.45
Myeloid leukaemia	7	11	18	14	0.50	0.18–1.25
ML_acute	3	7	13	9	0.30	0.06–1.11
ML_chronic	3	3	4	4	0.91	0.13–5.35
Liver	2	1	1	2	2.50	0.13–147.21
Lung	78	53	43	68	2.35	1.60–3.49
Adenocarcinoma	27	18	13	22	2.67	1.33–5.63
Squamous	19	10	5	14	4.95	1.79–16.96
Small-cell	14	10	9	13	2.10	0.85–5.50
Large-cell	8	7	9	10	1.14	0.38–3.34
Other	10	8	7	9	1.78	0.61–5.52
Melanoma	204	190	231	245	1.13	0.93–1.37
Mesothelioma	8	5	4	7	2.68	0.72–12.14
Multiple myeloma	8	4	11	12	2.19	0.76–5.98
NHL	35	32	39	42	1.17	0.72–1.89
Oesophagus	9	7	6	8	1.93	0.61–6.59
Oropharynx and larynx	52	42	44	54	1.52	1.00–2.33
Head and neck	44	32	28	40	2.02	1.23–3.37
Larynx	8	10	16	14	0.65	0.24–1.60
Pancreas	17	11	9	15	2.46	1.04–6.27
Thyroid	4	5	9	8	0.61	0.14–2.20
Unknown primary	21	19	23	25	1.19	0.63–2.24

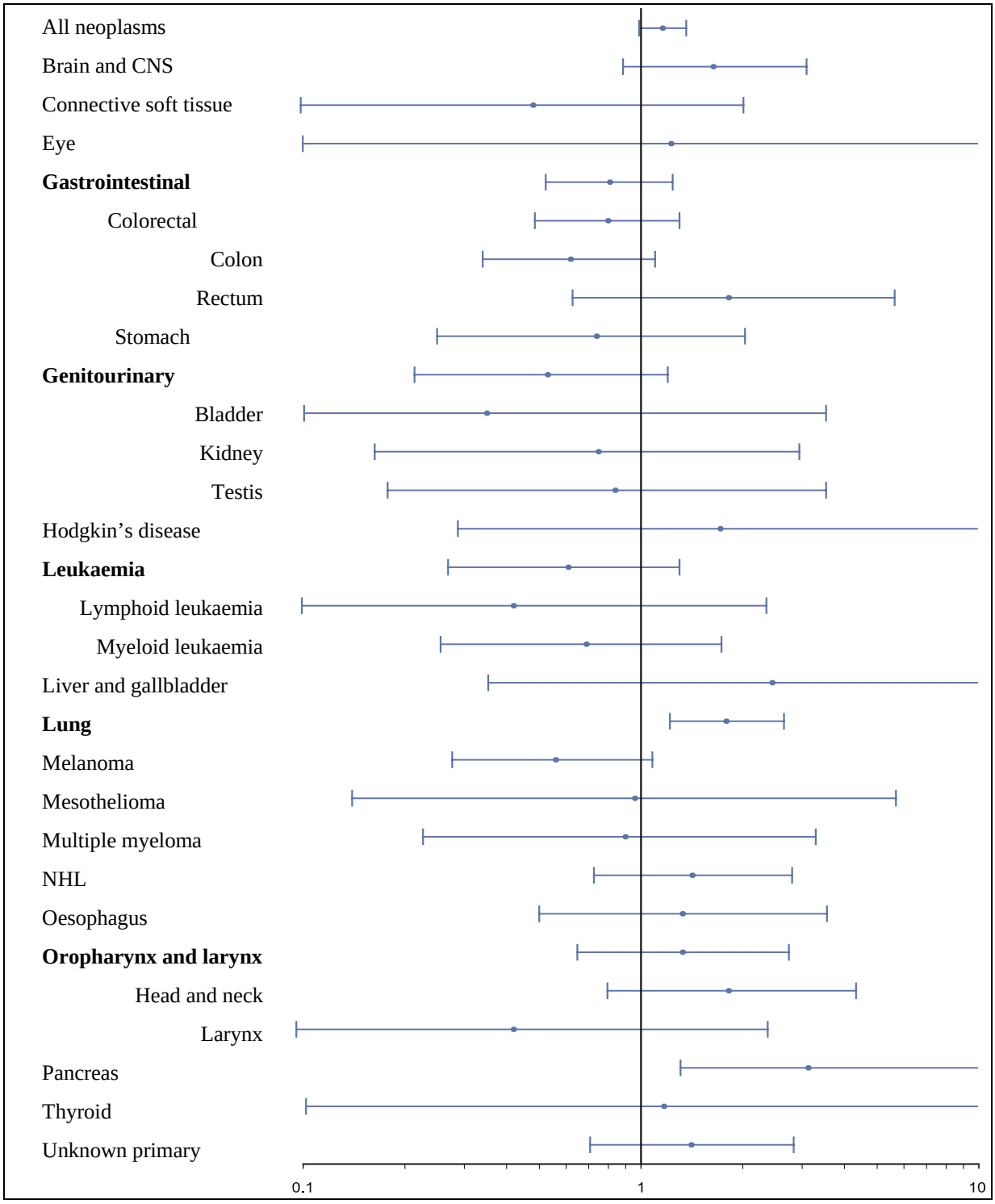


Figure 3-4: National servicemen cancer mortality (1966 – 2001), relative rates and 95% CI.

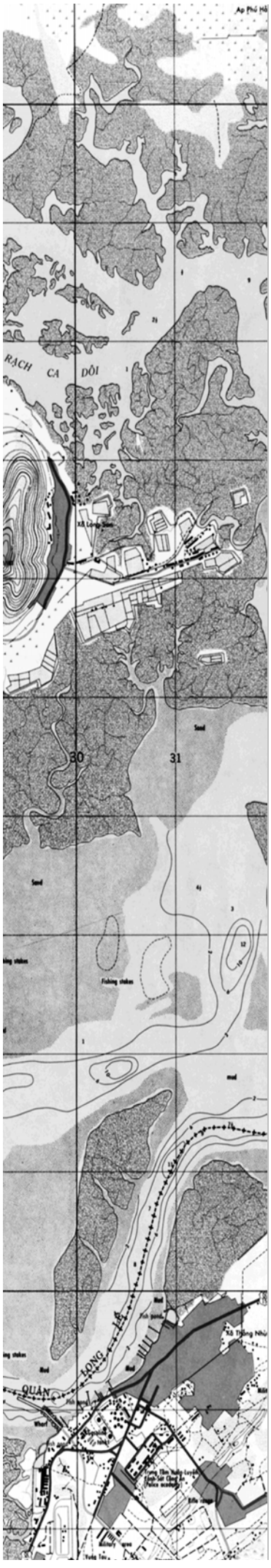
Table 3-4: Observed and expected numbers of cancer deaths (1966 – 2001) and the relative rates (RR) for National Service veterans and non-veterans

	Veterans		Non-veterans			
Cancer type	**Observed**	**Expected**	**Observed**	**Expected**	**RR**	**95% CI**
All neoplasms	290	268	320	342	1.16	0.98–1.36
Brain and CNS	27	21	20	26	1.64	0.89–3.09
Breast	0	0	0	0	–	–
Connective soft tissue	3	5	8	6	0.48	0.08–2.01
Eye	1	1	1	1	1.23	0.02–96.57
Gastrointestinal	37	42	58	53	0.81	0.52–1.24
Colorectal	29	33	46	42	0.80	0.48–1.30
Colon	19	26	39	32	0.62	0.34–1.09
Rectum	10	7	7	10	1.82	0.62–5.63
Stomach	7	8	12	11	0.74	0.25–2.03
Genitourinary	9	13	22	18	0.53	0.22–1.20
Bladder	1	2	4	3	0.35	0.01–3.53
Kidney	4	5	7	6	0.75	0.16–2.94
Prostate	0	2	5	3	0.00	0.00–1.41
Testis	4	4	6	6	0.84	0.17–3.52
Hodgkin's	4	3	3	4	1.72	0.29–11.77
Leukaemia	11	15	23	19	0.61	0.27–1.30
Lymphoid leukaemia	2	4	6	4	0.42	0.04–2.35
Myeloid leukaemia	8	10	15	13	0.69	0.25–1.73
Liver and gallbladder	4	3	2	3	2.45	0.35–27.06
Lung	67	50	48	65	1.79	1.22–2.65
Melanoma	14	20	32	26	0.56	0.28–1.08
Mesothelioma	3	3	4	4	0.96	0.14–5.68
Multiple myeloma	5	5	7	7	0.90	0.22–3.29
Nasal	0	0	1	1	0.00	0.00–48.22
NHL	21	17	19	23	1.42	0.73–2.80
Oesophagus	10	9	10	11	1.33	0.50–3.55
Oral cavity, pharynx and larynx	18	16	17	19	1.33	0.65–2.74
Head and neck	16	12	11	15	1.82	0.79–4.33
Larynx	2	4	6	4	0.42	0.04–2.37
Pancreas	19	12	8	15	3.13	1.31–8.26
Thyroid	1	1	1	1	1.17	0.01–91.69
Unknown primary	20	17	18	21	1.41	0.71–2.83

3.4 Summary of National Servicemen mortality and cancer incidence comparison

Taken together, the results show that although National servicemen had lower mortality and cancer incidence rates than the general population, veterans who served in Vietnam experienced a higher than expected mortality and cancer incidence compared to their colleagues who did not serve in Vietnam. Specific causes of death that contributed to the higher than expected mortality include death from diseases of the digestive system (primarily liver diseases), lung and pancreatic cancer and death from external causes such as suicide and motor vehicle accidents. The incidence of lung, pancreatic and head and neck cancers was also higher than expected.

Chapter 4 discusses the results presented in this chapter in the context of community norms, the healthy worker effect and published studies.



4

Discussion

Chapter 4 Discussion

This study investigates the mortality and cancer incidence of two similar groups: National Servicemen who served in Vietnam and Vietnam War era National Servicemen who did not serve in Vietnam. The two groups were compared to each other and to the Australian community norms.

4.1 Features of this Study

4.1.1 The healthy worker effect

The healthy worker effect (HWE) is a phenomenon observed in occupational health studies in which those who are employed exhibit a lower mortality rate than the general population. This effect is often primarily attributed to a selection bias whereby employed people are, on average, healthier than the general population, which includes those who are severely ill or disabled and thus unable to work. However, there are a number of other factors that contribute to and can modify the HWE. These include such factors as age group, job status, and ethnic background or race.[1]

The HWE is often referred to as the 'healthy soldier effect' for occupational studies of military cohorts. This distinction denotes the fact that military populations are far healthier than other employed populations, which in turn are healthier than the general population consisting of those employed and unemployed. This higher level of health and fitness is due to the active screening for chronic illnesses undertaken at enlistment into the military and the ongoing requirement to maintain good physical and mental health while serving (the active worker effect).[2] A great strength of this study is that it controls for the healthy worker or healthy soldier effect by comparing mortality and cancer incidence among National Servicemen with and without service in Vietnam. For readability this report uses the more common term HWE when referring to this effect.

The cohort of National Servicemen was selected at random by date of birth from the general population. They all underwent the same medical and psychological screening and the same basic training followed by specialised training for a corps or vocation such as infantry, engineer, or armour. Selection for specialised training was based on a number of factors; the preference of the National Serviceman, an assessment of the vocational ability of each individual and the manpower needs of the Army. Following specialist training, the National Servicemen were allocated to a unit. This allocation was made on the basis of need.

The decision about who would be sent to Vietnam was made after the National Servicemen were allocated to units. In general, a decision would not be made to send a particular individual to Vietnam but to send a particular unit to Vietnam and the National Servicemen previously allocated to that unit would go with that unit. Thus, the selection of an individual to be sent to Vietnam was very close to random, although selection of a unit was not. The major strength of this study is thus that it approximates a natural experiment with individuals assigned to service in Vietnam essentially at random, and it therefore largely controls for the healthy soldier effect. Both groups were composed of equally healthy, fit soldiers who at the time of entry into the study differed essentially only by their Vietnam service.

4.1.2 Study limitations

The study does, however, have some limitations. First, it does not have information about individual exposure to specific chemical or environmental hazards, either at the time of military service or subsequently. There is no exposure information for veterans regarding combat stress or possible exposure to herbicides such as Agent Orange or pesticides such as DDT. Nor does the study have individual information about life habits, such as cigarette smoking and alcohol consumption. The exposure in this study is overall deployment to Vietnam. Variations in the nature of that deployment or subsequent lifestyle or events for an individual are not known.

A second limitation is that there were no good measures of dose. Although information was available for time in Vietnam for the veteran group, time in Vietnam was not necessarily indicative of intensity of experience. Furthermore, detailed duration of military service information or corps grouping was not available for National Service non-veterans. However the criteria for inclusion on the study roll for National Service non-veterans was a minimum of 365 days military service.[3]

A third limitation is that the Servicemen were still relatively young by the end of the study (the majority was under 56 years old). As such, there are diseases of old age such as prostate cancer or degenerative mental disorders such as dementia, where few cases or deaths would be expected and meaningful observations on these conditions cannot be made.

Another limitation was that the lost to follow-up rate was higher among the Vietnam-era non-veterans (4.1%) than the veterans (2.2%). If the true vital status or cancer incidence of those lost to follow-up were substantially different between the groups, there could be an under or over estimation of mortality or cancer incidence among the Vietnam War era National Servicemen. However the method of determining cancer incidence and mortality was unlikely to have led to a differential ascertainment and most likely reflects the higher accuracy of the personal details in the veteran roll.

Finally as discussed in the previous section, selection for Vietnam service tended to be at the unit or corps level and not at the individual level. Thus the random assignment of Vietnam service was generally a cluster randomisation and ideally the analysis should adjust for this. Adjusting for within-cluster dependences

broadens the confidence intervals and reduces the possibility of type 1 errors, that is, wrongly inferring a statistically significant result. Analysis clustered by this level of service detail was beyond the scope of this study and furthermore this information is not available for an equivalent comparison with the non-veteran group.

4.2 Discussion of comparison with community norms

This study has shown that National Servicemen of the Vietnam War era exhibit a strong healthy worker effect. This selected cohort displays an overall mortality rate that is significantly lower than similarly aged Australian males. The demonstration of a healthy worker effect is to be expected in this relatively young cohort that was selected approximately 35 years ago for a high level of health and fitness.

For the over 60 specific causes of cancer or non-cancer mortality investigated, no cause of death was significantly more common than expected within the Australian community and many were significantly less common than expected. However there were three cancer sites (melanoma, eye cancer and Hodgkin's disease) among the total National Servicemen cohort which displayed a significantly higher than expected incidence compared to the Australian community. For National Service veterans the incidence of melanoma and eye cancer (which histologically is primarily melanoma) was significantly higher than community norms, whereas National Service non-veterans had higher than expected incidence of Hodgkin's disease.

4.3 Discussion of National Service comparison

Despite the overall decrease in mortality compared with the Australian community, when mortality and cancer incidence was compared between the two healthy groups of National Service veterans and non-veterans, the veteran cohort displayed a significant and marked higher mortality and cancer incidence compared to the non-veteran cohort. The rest of the chapter discusses the specific results of this comparison.

4.3.1 Non-cancer mortality

The 23% higher overall mortality amongst National Service veterans was due primarily to a significant elevation in mortality due to digestive system diseases (predominantly liver diseases) and to an elevation of mortality from external causes specifically motor vehicle accidents and suicide. Mortality was also elevated for some specific cancers, such as cancer of the lung and pancreas, and these are discussed in Section 4.4.

In the previous study of this cohort,[3] overall mortality was elevated by 15% in veterans compared to non-veterans and this was of borderline statistical

significance. Significantly elevated mortality ratios were also noted for diseases of the digestive system and for lung cancer.

4.3.2 Digestive diseases

The mortality from digestive diseases amongst National Service veterans was more than double that of non-veterans, RR = 2.25 (95% CI 1.44, 3.56). This result is consistent with the results of the previous mortality study of National Servicemen.[3]

Liver diseases

The majority of deaths within the digestive disease group were due to diseases of the liver, gall bladder and bile ducts (51 deaths of 58 total) and three quarters of these deaths were due specifically to alcoholic liver disease. The standardised mortality ratio from alcoholic liver disease was also elevated amongst veterans compared to community norms, but this result did not reach statistical significance. This would suggest that the National Service veterans, or a subset of these, consumed more alcohol than their non-veteran counterparts.

4.3.3 External Causes

There was an elevation in the relative rate for mortality due to external causes amongst National Service veterans since completion of their Vietnam service, (RR = 1.26 (95% CI 1.09, 1.46). The previous study of this cohort showed a 10% elevation in mortality from these causes amongst veterans for the period of 1982 to 1994, which was not statistically significant.[3]

Motor Vehicle Accidents (MVA)

There was a 31% increase in the rate of MVA mortality among veterans compared to non-veterans, RR = 1.31 (95% CI 1.01, 1.68). This relative rate is higher than seen in the previous study, which showed a 10% elevation that was not statistically significant and, as discussed above, this may correspond to the limited analysis period for this cause of death (1982 – 1994). There has been speculation that in any population some motor vehicle accidents are in fact suicide. However, a Finnish study concluded that less than 6% of motor vehicle fatalities were intentional, so the misclassification rate of suicides as MVAs may be small.[4]

Suicide

There was a significant increase in the relative rate for suicide, based on 129 deaths observed amongst the National Service veterans and 115 deaths observed amongst non-veterans. This gave a relative rate of 1.43 (95% CI 1.10, 1.85). This relative rate was higher than that noted in the previous study of this cohort.[3] Several American studies also indicate an increase in suicide rates for those who served in the military during the Vietnam War era[5 6] or specifically served in Vietnam[7]. Later studies show that those who were wounded in Vietnam or suffering from PTSD were most at risk of suicide.[8-11]

4.3.4 Mortality from other diseases

There were other non-cancer causes of death analysed for which the point estimate of the relative rate suggested a higher level of mortality amongst National Service veterans compared to non-veterans but the result did not reach statistical significance. Specifically, those causes of death include mortality from mental disorders, motor neurone disease and ischaemic heart disease. These and other findings are discussed below.

Mental disorders

There was a borderline significant elevation in mortality from mental disorders, with a relative rate of 2.75 (95% CI 0.98, 8.83). The number of deaths for this group of diseases was small enough for an examination to be made for the 19 deaths involved. All of the deaths were due to conditions associated with alcohol or drug misuse again suggesting that the veteran population consumed more alcohol than the non-veterans.

Motor Neurone Disease (MND)

Although there were very few cases of MND (n=7), there was a large increase in relative rate for MND, and this was of borderline statistical significance, RR = 4.73 (95%CI 0.98, 22.76). The incidence of this disease increases with age and the age range of the National Service cohort in this study is generally below the mean age of onset[12] thus it is possible that further studies may be more informative.

No clear risk factors for MND, also known as amyotrophic lateral sclerosis (ALS), have been established.[12] About 5% of cases are familial but no association with a tissue type has been identified.[13] However several possible exogenous risk factors have been suggested including exposure to agricultural chemicals such as pesticides or herbicides,[14] cigarette smoking (but not alcohol consumption)[15] and electromagnetic fields.[16 17] An elevated risk has also been reported among aviation pilots, navigators[18 19] and athletes.[20]

Several studies have indicated that military personnel are also at greater risk for MND. An occupational study from the United States in 1996 found that military personnel had a higher proportionate mortality for MND.[21] A study completed in the United States suggested that Gulf War veterans are at greater risk for the development of MND, with the highest risk amongst deployed Air Force personnel.[22] More recently, a comprehensive study of 500,000 men showed that military service in general was associated with increased risk and this was across all Service branches except for the Marines.[23]

Studies of Australian Vietnam veterans have shown mixed results for the association of service with MND. The previous study of the National Service cohort showed a borderline statistically significant elevated mortality rate for neurological disorders among veterans compared to non-veterans.[3] A validation study of self-reported illness showed no statistically significant difference in the incidence of MND for Vietnam veterans compared with the Australian

community, however under some models of analysis the number of cases identified were at the upper limit for the community standard.[24] In the recent mortality study of all Australian Vietnam veterans, Army and Air Force personnel had a higher rate of death from MND compared to the Australian population, but these results were not statistically significant.[25]

Other nervous system diseases

There were relatively few deaths for the other diseases of the nervous system and there was no appreciable difference in mortality between the veterans and non-veterans. Mortality from many of the diseases in this group, such as Parkinson's disease and dementia, generally would not be expected in a cohort of this age. Other diseases, such as cerebral palsy, would have excluded a person from military service.

Cardiovascular diseases

Overall mortality from circulatory system diseases did not differ between veterans and non-veterans. Two major diseases make up this disease group; ischaemic heart disease (IHD) and cerebrovascular disease.

IHD is the single most prevalent cause of death in Australia, resulting in the death of about a fifth of all people.[26] In this study, the rate of death due to IHD among the National Service veterans was elevated by 18% compared to the non-veteran group, RR = 1.18 (95% CI 0.94, 1.47), although this was not statistically significant. The mortality rate from IHD increases sharply with age after the fifth decade, which is the age range that this cohort is now approaching and more information on the impact of this disease on the veteran group may be available in later years.

In contrast, the mortality from cerebrovascular disease was 39% lower amongst National Service veterans than non-veterans, but this result was not statistically significant. Major risk factors for cerebrovascular disease are hypertension, diabetes and hyperlipdemia.[13 27]

It would be expected that IHD would be strongly affected by the healthy worker effect in the National Service population and the data confirms this. The standardised mortality ratios for both National Service groups were well below expectation when compared to the Australian community.

Chronic Obstructive Pulmonary Disease (COPD)

The mortality from COPD did not differ between the two National Service groups. The number of deaths in both groups was relatively small and the mortality for this condition did not differ from community norms.

The major risk factor for COPD in Australia, as in all Western society, is cigarette smoking.[13] The mortality from this disease tends to increase after the age of 65. Thus this cohort is currently too young to make meaningful comments on the role of COPD on mortality within National Servicemen.

HIV/AIDS

The relative rate of death from HIV/AIDS was very close to unity and the standardised ratios did not differ from community norms. This suggests that the Vietnam experience had no effect on the subsequent rate of death from HIV/AIDS.

Endocrine, nutritional and metabolic diseases

As would be expected in this selected cohort, the mortality ratio from endocrine diseases was significantly below community expectations and it also did not differ between veterans and non-veterans.

There were 16 deaths from diabetes among the National Servicemen. The coding for diabetes does not distinguish between the different types of diabetes. The deaths observed amongst the National Servicemen would most likely be due to Type II diabetes as Type I generally becomes evident in juveniles and this would have been detected at the medical screening prior to enlistment. There is a long latency for mortality from this chronic disease and this population may be too young for meaningful understanding of the mortality from Type II diabetes at this stage.

4.4 Cancer incidence and mortality

The incidence of cancer was assessed for the period 1982 to 2000 whereas the mortality due to cancer was assessed from the time of completion of Vietnam service (or age of 22 for non-veterans) to 2001. It is important to bear in mind the different study periods when interpreting cancer incidence and mortality rates and also to note the incidence and mortality results are not directly comparable.

Compared to the general population, the overall cancer incidence and mortality amongst the National Servicemen cohort and veteran and non-veteran groups were either below or not significantly different from community norms. Although, the standardised incidence of three individual cancer sites, melanoma, eye cancer and Hodgkin's disease, was significantly elevated amongst the whole cohort of National Servicemen compared to the Australian community, no standardised mortality ratios were significantly elevated.

National Service veterans, however, showed a significant 14% increase in cancer incidence compared to the National Servicemen who did not serve in Vietnam, RR = 1.14 (95% CI 1.04, 1.26). Overall mortality from cancer was also elevated to a similar extent but this was of borderline statistical significance, RR = 1.16 (95% CI 0.98, 1.36).

The specific cancer types primarily contributing to the elevated relative incidence rate were cancers of the lung, head and neck and pancreas. For cancer mortality significant elevations in relative rates were noted for cancer of the lung and pancreas. The results for these and other cancer sites are discussed below.

4.4.1 Lung Cancer

The incidence of lung cancer amongst National Service veterans was more than double that for non-veterans, RR = 2.35 (95% CI 1.60, 3.49). The relative mortality rate was elevated by 79%, RR = 1.79 (95% CI 1.22, 2.65). The accompanying cancer incidence and mortality reports for all Vietnam veterans also showed a higher than expected lung cancer incidence and mortality for all Army veterans, of which the National Service veterans are a subset, compared to the general population.[25 28]

Vietnam veterans may have had a number of exposures that increased their rates of lung cancer. Smoking is a major risk factor for lung cancer.[29] A previous morbidity study has suggested that Australian Vietnam veterans did smoke at a rate greater than the Australian community,[30] however the present study does not have information on smoking rates amongst National Servicemen.

An increase in the rate of lung cancer would be consistent with some other studies of chemical exposure among Vietnam veterans. The study of Ranch Hand veterans has found an elevation in the rate of lung cancer, with an incidence of 3.7 (95%CI 0.8 – 17.1), that was not statistically significant.[31] Similarly, a study of cancer rates in the US Army Chemical corps found an SMR of 1.4 (95% CI 0.4 – 5.4).[32] In addition, a series of large studies of proportionate mortality in American Vietnam veterans demonstrated small but significant elevations in lung cancer rates.[5] A case-control study of lung cancer also demonstrated a slight elevation in risk.[33] In summary, while many of the other studies do not show elevations of statistical significance, there is some consistency in studies of Vietnam veterans that suggests that they are, as a group, at greater risk of developing lung cancer.

The carcinogenic potential of 2,3,7,8-tetrachlorodibenzo-p-dioxin has also been proposed as a risk factor for lung cancer. An analysis of several exposed industrial cohorts revealed an increase in the overall level of cancer and, amongst those workers with prolonged exposure and a greater than 20 year latency, lung cancer was also significantly elevated.[34] Another smaller study of an industrial cohort found no evidence of an association.[35] A study of a heavily contaminated town in Russia revealed significantly higher than expected mortality from lung cancer.[36] The latest update of the *Veterans and Agent Orange* report concluded that there was limited or suggestive evidence of an association between dioxin exposure and lung cancer.[37]

The histological subtype of diagnosed lung cancers was also investigated amongst National Servicemen. Although the overall lung cancer incidence rate was double, National Service veterans had a nearly five fold higher rate of the squamous cell subtype compared to the non-veteran group. However, in absolute numbers the adenocarcinoma histology amongst the veterans was predominant (27 cases), followed by squamous cell (19 cases) and then small cell (14 cases).

A secular trend in Australia and elsewhere has been noted which shows an increased incidence of the adenocarcinoma subtype.[38 39] In the accompanying cancer incidence study of all Vietnam veterans, the adenocarcinoma subtype was

the predominant histological type and the subtype exhibiting higher than expected incidence.[28]

Some have speculated that the observed secular proportional change in histological subtype may be due to increased use of filtered, low-tar cigarettes.[40] In contrast to earlier studies,[41 42] a large study of lung cancer histology among US women showed that the adenocarcinoma subtype was the subtype most strongly associated with smoking in both current and former smokers.[43]

4.4.2 Mesothelioma

There were 12 cases of mesothelioma diagnosed amongst the National Servicemen, eight amongst the veteran group and four amongst the non-veteran group, giving a relative incidence rate more than double than expected. However the number of cases was small and the result was not statistically significant. Mortality from this disease could be assessed only from 1997 when mesothelioma was separated from lung cancer and assigned a unique code. The relative mortality rate for this disease amongst the veterans compared to non-veterans was close to unity.

The major risk factor for mesothelioma is exposure to asbestos and risk is increased substantially if a person also smokes.[44]

The mortality figures for mesothelioma are most likely an under-ascertainment, as some deaths from this disease would have been classified as lung cancer deaths because of the coding practices prior to 1997. This disease has a long latency period and its impact may become clearer in later years.

4.4.3 Cancer of the Head and Neck

The cancers in this group include cancer of the tongue, gum, mouth (but not the lip), palate, salivary glands, tonsils, oropharynx and nasopharynx. The relative incidence of head and neck cancer was significantly higher than expected for the National Service veterans, RR = 2.02 (95% CI 1.23, 3.37), and the relative mortality rate was also elevated, RR = 1.82 (95% CI 0.79, 4.33), but this was not statistically significant. These results are consistent with the findings for the total Vietnam veteran cohort which showed a significantly higher than expected mortality and cancer incidence for head and neck cancer compared to the general population.[25 28]

The major risk factors for this cancer are smoking and alcohol consumption.[29] The result amongst National Service veterans is therefore consistent with the increased mortality for alcoholic liver disease and lung cancer.

Interestingly, however, the relative rate and standardised incidence and mortality ratios for cancer of the larynx, which is also associated with smoking and alcohol consumption, were not increased amongst the veteran group.

4.4.4 Pancreatic cancer

The relative incidence and mortality rate for pancreatic cancer were significantly higher than expected, RR = 2.46 (95% CI 1.04, 6.27) for incidence and RR = 3.13 (95% CI 1.31, 8.26) for mortality. The standardised incidence and mortality ratios were also elevated for veterans compared to the general population but did not reach statistical significance. The previous study of National Service veterans also indicated a much higher than expected relative mortality rate from pancreatic cancer compared to non-veterans, although again this did not reach statistical significance.[3]

A major risk factor for pancreatic cancer is smoking.[29] Information on smoking is not available for National Servicemen. However, results for the incidence of other cancers associated with smoking, such as lung and head and neck cancers, suggest that the veteran population smoked more than the non-veteran group.

Several studies have shown an association with herbicide and pesticide exposure and an increase in pancreatic cancer among agricultural workers.[45-47] However, although one study of female Vietnam veteran nurses showed an increased relative rate,[48] the *Veterans and Agent Orange* report concluded there was no evidence of an association between dioxin exposure and pancreatic cancer.[37]

4.4.5 Melanoma

The relative incidence rate for melanoma was above unity for National Service veterans, RR = 1.13 (95% CI 0.93, 1.37) whereas the relative mortality rate was below unity, RR = 0.56 (95% CI 0.28, 1.08), but neither effect was statistically significant. A similar discordance in incidence and mortality was observed for the indirect analysis comparing veterans to the Australian population. The standardised incidence ratio was 25% significantly higher than expected amongst National Service veterans (SIR = 1.25) whereas the SMR was significantly lower than expected (SMR = 0.56). In contrast, amongst National Service non-veterans the standardised incidence ratio for melanoma was higher than expected, although not significantly so, the mortality for this condition was not different from expectation based on community rates.

The accompanying cancer incidence report on the entire cohort of Vietnam veterans showed that the incidence of melanoma was significantly higher than expected for all Vietnam veterans and across all Service branches,[28] whereas the mortality ratio for melanoma was significantly higher than expected for Navy veterans only.[25] In the previous study of National Servicemen mortality from melanoma did not differ between the veteran and non-veteran groups.[3] In the previous mortality study of all Vietnam veterans, published in 1997, the mortality ratio for melanoma was higher than expected, but this was of borderline statistical significance.[49]

The major risk factor for melanoma is excessive sunlight especially among those of Northern European ancestry and Australia has one of the highest incidence rates of this cancer in the world.[50] However, with early detection and treatment, mortality from melanoma can be substantially reduced. The results from the

present study would suggest that National Service veterans are at higher risk for melanoma but have received more effective early detection and treatment for this cancer than non-veterans.

4.4.6 Gastrointestinal cancers

Although the incidence for gastrointestinal cancers did not differ from the Australian population for either veterans or non-veterans, the veteran group had a 30% significantly lower than expected mortality whereas the non-veteran group had a non-significant 15% reduction in mortality ratio. However, in the direct comparison of National Service veterans to non-veterans, incidence and mortality for gastrointestinal cancers did not differ significantly between the groups, although there was a suggestion of lower mortality for the veterans.

The site-specific cancers investigated in this group were cancers of the colon, rectum (colorectal) and stomach. These three sites comprise over 95% of the cancers diagnosed within the gastrointestinal group. The incidence and mortality for these sites did not differ significantly between the National Service groups although National Service veterans tended to have proportionally more rectal cancers and less stomach cancers diagnosed than the non-veteran comparison group.

Although a small proportion of gastrointestinal cancers have a genetic component, a major risk factor for colorectal cancers is a diet high in meat, fat and alcohol[29] and for stomach cancer the major risk factor is infection with *Heliocobactor pylori*.[51] Colorectal cancer is generally a slowly progressing disease presenting from pre-cancerous polyps, which if removed does not result in metastatic disease.[13] The significantly lower standardised mortality ratio for gastrointestinal cancers amongst the veteran group, combined with a standardised incidence ratio that is close to expectation with community rates may suggest that veterans have received early diagnosis and treatment for these conditions.

4.4.7 Genitourinary cancers

The cancers in the genitourinary group include cancers of the bladder, kidney, prostate and testis. Although this cancer group was the second most frequently diagnosed cancer, there were few deaths observed during the period of study.

In the direct comparison, incidence and mortality for any of the cancers in this group did not differ between the National Service groups nor were the incidence ratios for either veterans or non-veterans different from expectation in the indirect analysis. However, the veteran subgroup showed a significant reduction in mortality for genitourinary cancers overall compared to the general population (although this was based on no observed deaths compared to 5 expected), and specifically prostate cancer, whereas the standardised mortality ratios for non-veterans did not differ significantly from expectation.

In the accompanying cancer incidence report of all Vietnam veterans, the incidence ratio of prostate cancer was higher than expected across all service

branches, although the Navy results did not reach statistical significance.[28] In addition, the mortality ratios for prostate cancer across the Service Branches were 17%-38% higher than community norms, but these results were not statistically significant.[25]

National Servicemen are below the age of peak incidence for prostate cancer and this cancer will be of greater importance for this group in the coming years.[50] Prostate cancer is most frequently diagnosed in the sixth and seventh decade of a man's life and is generally slow growing. The suggestion of a discordance between incidence and mortality rates for the National Service veteran group is of interest but as few deaths were observed, longer follow-up would be needed to clarify the relationship.

4.4.8 Leukaemia

There were 50 cases of leukaemia diagnosed amongst the 43,969 National Servicemen in the period from 1982 to 2000. Although there were proportionally more cases of acute myeloid leukaemia amongst the non-veteran group, the rates of incidence and mortality for all leukaemia and the different subtypes analysed did not differ significantly between the National Service veterans and non-veterans nor did the rates in either group differ from expectation based on community rates.

Following childhood, the peak incidence for the leukaemias is generally after the age of 65,[50] accounting for the relatively low number of cases observed in this cohort. Similarly, the previous study of National Servicemen had too few deaths from leukaemia to make meaningful observations.[3] The specific subtype, chronic lymphoid leukaemia, will be discussed in Section 4.4.10, Cancers associated with dioxin exposure.

4.4.9 Multiple myeloma

The incidence of multiple myeloma was more than double amongst the veteran cohort compared to non-veterans. However, the number of cases was small and the result was not statistically significant. Mortality for multiple myeloma did not differ between the National Service groups and the incidence and mortality for either veteran group were not significantly different compared with the Australian community.

In the accompanying reports, the standardised incidence ratio for multiple myeloma for all Vietnam veterans and Army veterans was significantly lower than expected and the mortality ratio non-significantly lower.[25 28] In previous studies of Australian Vietnam veterans and National Servicemen the number of cases were too few for meaningful interpretation of the results.[3 49]

Multiple myeloma has its peak incidence in the seventh decade of life.[13] Although the aetiology of this disease is unknown it has been associated with exposure to herbicides and pesticides among farmers,[52] environmental exposure to dioxin,[53] occupational exposure to aircraft maintenance[54] and sheet metal work[55] but not

associated with the Vietnam veteran Ranch Hand cohort[31]. The *Veterans and Agent Orange* report[37] concluded there was limited or suggestive evidence of an association between herbicide exposure and multiple myeloma.

4.4.10 Cancers associated with dioxin exposure

The *Veterans and Agent Orange* report[37] lists four cancers for which they consider there is sufficient evidence of an association with herbicide exposure. Those cancers are cancer of the connective soft tissue, chronic lymphoid leukaemia, non-Hodgkin's lymphoma and Hodgkin's disease, and the results for these cancers for National Servicemen are discussed below.

Cancer of the connective soft tissue

Cancer of the connective soft tissue has been associated with exposure to a variety of environmental factors such as ionising radiation, arsenical pesticides, alkylating agents, dioxin and some viruses as well as some heritable conditions.[56] In this study of National Servicemen, there were no significant differences in either standardised incidence or mortality for the veterans or non-veterans compared to the general population or in the direct comparison between the two groups of National Servicemen.

Chronic lymphoid leukaemia

This study detected 19 cases of chronic lymphoid leukaemia diagnosed amongst National Servicemen between 1982 and 2000. Compared to the general population, the incidence was elevated for both the veteran and non-veteran groups, but the confidence intervals were wide and the results were not statistically significant. Comparing the two National Service groups showed no difference in incidence. The mortality data differentiates only to the lymphoid or myeloid level but shows a trend towards lower mortality for lymphoid leukaemia amongst the veteran group in both indirect and direct analyses.

The accompanying cancer incidence report of all Vietnam veterans also shows a statistically significant elevation in SIR for chronic lymphoid leukaemia amongst all veterans and the Army veterans with a trend toward higher than expected incidence for Navy veterans.[28] The mortality results showed a trend towards higher than expected mortality from lymphoid leukaemia amongst all Vietnam veterans.[25] The peak incidence for this disease is in the sixth and seventh decade of life and the cohort of National Servicemen may be too young to make a meaningful assessment of the impact of this disease.

Non-Hodgkin's lymphoma (NHL)

The incidence and mortality from non-Hodgkin's lymphoma (NHL) were elevated for National Service veterans compared to non-veterans, but these results were not statistically significant. The standardised incidence ratios for both groups were significantly lower than expected but mortality was within community norms.

NHL shares many characteristics with chronic lymphoid leukaemia and classification of these two cancers often overlap.[13] The accompanying cancer incidence report shows a statistically significant lower than expected incidence of NHL, particularly in the Army group, compared with the Australian population.[28] Similarly, standardised mortality for NHL was significantly lower than expected.[25] The previous mortality reports showed no significant difference from community norms[3 49].

As well as the *Veterans and Agent Orange* report[37] concluding there was sufficient evidence of an association between herbicide exposure and NHL, an increased risk for NHL has been associated with those working in occupations, such as agriculture, forestry, metal working, motor vehicle and aircraft maintenance and welders.[54 57] NHL has also been associated with conditions which reduce immune function.[58]

Although NHL does not seem to be of major concern for the National Servicemen, this cohort may not yet have reached the age where the full impact of this disease is evident.

Hodgkin's Disease

There was no difference in incidence or mortality for Hodgkin's disease between the National Service groups. The incidence of Hodgkin's disease for the veterans group did not differ from community norms whereas the incidence for non-veterans was significantly elevated. Mortality for these service groups did not differ significantly from community norms.

The previous mortality studies did not show any difference from community norms for Hodgkin's disease for all Vietnam veterans or National Servicemen, although the number of cases were very small.[3 49] However in the accompanying cancer incidence report of all Vietnam veterans, Army veterans experienced a rate of Hodgkin's disease twice that of the Australian population,[28] but mortality was within community norms.[25] This difference may reflect the older age distribution for the Army cohort compared to the subgroup of National Servicemen.

Hodgkin's disease affects males twice as frequently as females and has two peaks of incidence, one in young adults and the other in the elderly[13]. The study period for the National Servicemen cancer incidence analysis would generally not have included the first incidence peak and would not yet capture the second peak. Furthermore, with improved treatment, mortality from this disease is relatively low and although the mortality analysis covers a longer time period, it would not capture the full extent of Hodgkin's disease in this population. Other risk factors associated with Hodgkin's disease besides herbicide exposure include Epstein-Barr virus infection and genetic factors.[13]

In summary, none of the four cancers that have sufficient evidence of association with dioxin exposure were significantly more frequent amongst the National Service veterans compared to the non-veteran group, nor were the standardised incidence or mortality ratios significantly elevated among these groups compared to the general population.

4.5 Summary and Conclusions

This study compared the mortality and cancer incidence of two groups of military personnel who at the time of enlistment were a similar age and at similar levels of health and fitness. The study, therefore, controlled for the healthy worker effect and analysed the effect of Vietnam service for National Service veterans.

The study showed that as a group National Servicemen were generally healthier than the same aged Australian male population. However those who served in Vietnam had significantly greater mortality for a number of conditions compared to their non-veteran counterparts. These included overall mortality, mortality from digestive disease, particularly alcoholic liver disease, and deaths from external causes, particularly motor vehicle accidents and suicide. In addition, overall cancer incidence was elevated and specifically the incidence of cancer of the lung, head and neck and pancreas was elevated. Mortality from cancer of the lung and pancreas was also significantly elevated. There was no condition analysed for which National Service veterans had a significantly lower rate of mortality or cancer incidence than the non-veteran group.

There were also a number of conditions for which the relative rates were higher than expected but the results were of borderline statistical significance. These conditions included mortality from neoplasms, mental disorders, motor neurone disease and to a lesser extent, mortality from ischaemic heart disease and the incidence (but not mortality) from melanoma.

For some conditions the pattern of relatively higher incidence but lower than expected mortality among the veterans may suggest that their conditions and/or their risk factors were detected earlier and appropriately managed. These include a number of cancers such as melanoma and colorectal cancer and to a lesser extent a proportionally lower mortality from cerebrovascular disease and prostate cancer.

The study showed contradictory results for those conditions associated with herbicide/dioxin exposure. The incidence for a number of cancers strongly associated with herbicide exposure, such as connective soft tissue cancer, Hodgkin's disease, chronic lymphoid leukaemia and non-Hodgkin's lymphoma did not differ significantly between the National Service groups. Two of the three cancers which have been categorised as having suggestive evidence of an association, that is lung cancer and multiple myeloma, were more frequent amongst veterans, whereas the third cancer in this category, prostate cancer, did not differ between the groups.

In conclusion, two groups of fit healthy men who were enlisted into military service more than 30 years previously were compared. Those who served in the Vietnam War experienced higher levels of mortality and cancer incidence than those who served in Australia. Furthermore, for the period under study this cohort of National Servicemen was generally younger than the peak age of incidence for many of the diseases of interest. As this cohort ages clearer patterns of disease may emerge.

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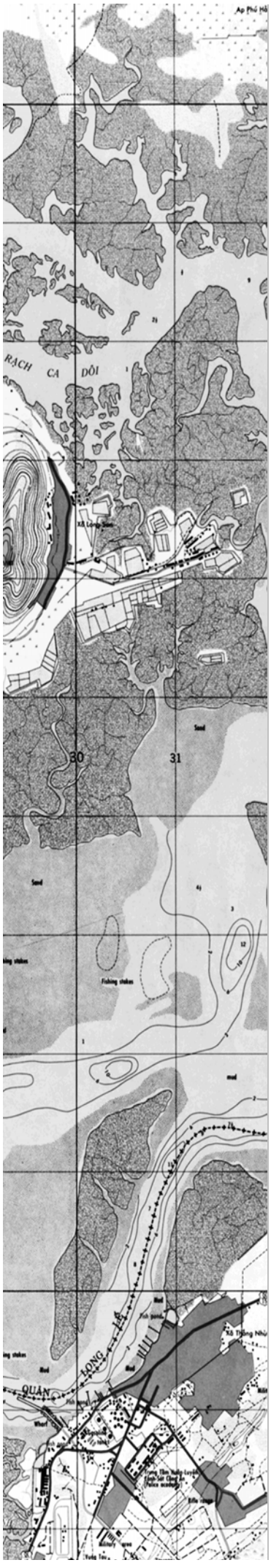

Literature Review of Health Effects of Vietnam Service

Appendix A Literature Review of Health Effects of Vietnam Service

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

Glossary

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

Literature Review of Health Effects of Vietnam Service

A.1. Introduction

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

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

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

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

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

A.2. Studies of Australian Vietnam veterans

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

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

A.2.1. Australian Veterans Health Study (AVH)

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

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

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

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

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

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

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

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

A.2.3. Vietnam Veteran Mortality Study (VVMS)

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

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

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

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

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

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

A.2.4. Mortality of National Service Vietnam Veterans study

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

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

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

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

A.2.5. The Australian Vietnam Veterans Health Study

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

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

A.2.6. Morbidity of Vietnam Veterans studies

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

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

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

A.2.6.1 Health of Vietnam veterans' children

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

A.2.7. Other studies

A.2.7.1 Reproductive health

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

A.2.7.2 Psycho-social health of Vietnam veterans

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

A.2.8. Summary of results of Australian studies

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

A.3.2.2 Hepatobiliary cancers (C22-C24)

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

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

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

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

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

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

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

A.3.2.4 Laryngeal cancer (C32)

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

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

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

A.3.2.5 Lung cancer (C33, C34)

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

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

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

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

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

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

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

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

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

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

A.3.2.7 Melanoma (C43)

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

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

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

A.3.2.8 Prostate cancer (C61)

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

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

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

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

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

A.3.2.9 Testicular cancer (C62)

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

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

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

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

A.3.2.10 Bladder cancer (C67)

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

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

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

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

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

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

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

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

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

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

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

A.3.2.12 Hodgkin's disease (C81)

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

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

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

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

A.3.2.13 Multiple myeloma (C90)

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

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

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

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

A.3.2.14 Leukaemia (C91-C95)

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

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

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

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

A.3.2.15 Conclusions for neoplasms (C00–D48)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

A.4. Summary and Discussion

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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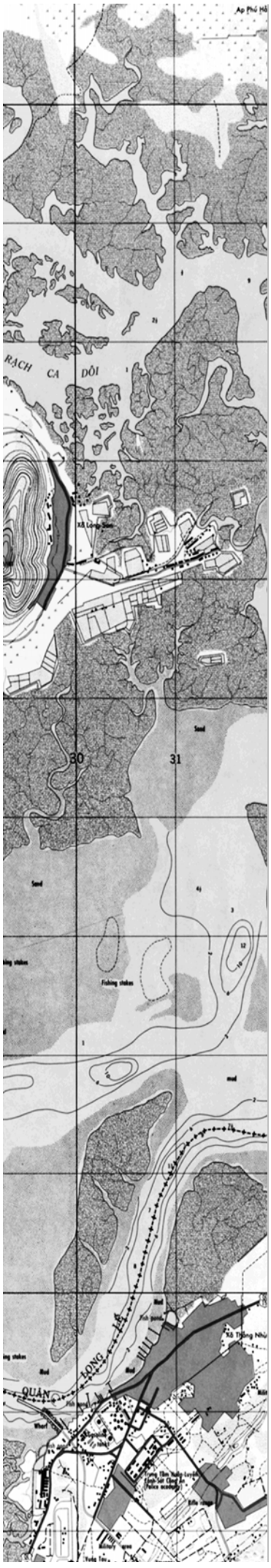

B

Study Protocol

Appendix B Study Protocol

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

Abbreviations

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

Protocol

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

B.1. Background

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

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

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

B.2. Aims

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

To answer the hypothesis the study aims will be:

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

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

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

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

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

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

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

B.3. Overview of study design

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

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

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

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

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

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

B.3.1. Definition of Vietnam veteran

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

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

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

This definition excludes:

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

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

B.3.1.1 Male veterans

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

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

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

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

B.4. Comparisons of interest

B.4.1. General

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

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

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

B.4.2. Ships crews and passengers

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

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

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

B.4.3. Dapsone exposure

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

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

B.4.4. Specific causes of death to be examined

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

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

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

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

B.5. Literature review

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

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

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

B.6. Legislation

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

B.6.1. The Privacy Act 1988

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

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

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

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

B.6.2. The Commonwealth Electoral Act 1918

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

B.6.2.1 Data collection and processing

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

B.6.3. Nominal Roll

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

B.6.4. Determining vital statistics

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

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

B.6.4.1 Search of DVA Client Data Base

DVA maintains an automated database, the Client Data Base, which provides a central, authoritative source of information about veterans who have registered for any benefit provided by Veterans' Affairs. The DVA maintains stringent checks and balances for its Client Data Base (CDB). If a veteran is in receipt of a DVA payment, then that veteran is assumed alive. Files showing that a veteran has died have been confirmed by evidence of a death certificate sighted by an officer of the DVA. However cause of death is not always recorded.

Although there are over 42,000 Vietnam veterans recorded on the CDB, the database does not have data on Vietnam veterans who have not registered for any benefit provided by Veterans' Affairs and those short-term visitors and others not covered under Repatriation legislation. For these veterans it will be necessary to check other data bases, and in turn information about Vietnam veterans from these other data bases can be cross-checked against the DVA CDB to increase the reliability of data.

B.6.4.2 Search of National Death Index

The AIHW maintains the National Death Index (NDI), which collates data from the death registries from individual States and Territories. The NDI includes a mortality database which contains information on each person's underlying cause of death by International Statistical Classification of Diseases, Injuries and Causes of Death (ICD) code. ICD-9 classification was used from 1979 to 1996 and use of the ICD-10 classification commenced in 1997.

In the *VVMS*, the NDI matching was problematic in that it identified only 60% of deaths not known to DVA from the CDB. Furthermore, approximately 20% of matches with the NDI determined incorrectly that a live subject was dead. Liaison with the AIHW has determined that the researchers can expect an improvement of the matching results. Nevertheless, adjustments to the statistical analysis may need to be considered to correct for under-ascertainment.

B.6.4.3 Search of electoral rolls

Nominal Roll veterans will be matched against the most recent Australian electoral records to identify:

- those veterans who are known to have been alive at the date of the electoral roll compilation; and
- those not confirmed to be alive.

The matching of the Nominal Roll to the electoral roll will be done by the AIHW.

B.6.4.4 Search of Medicare database by the Health Insurance Commission

The veterans will be matched with the Medicare claim database. Each matched record can be linked to the claim database to determine the date on which the subject last received a medical service, that is, the date they were last known to be alive.

B.6.4.5 Search of cancer registers

The Nominal Roll will be matched against the National Cancer Statistics Clearing House (NCSCH). This match will identify those who have died of cancer and those who currently have cancer but are still alive. The veterans diagnosed with cancer identified through the NCSCH will form the basis for the Cancer Incidence Sub-study.

The AIHW will perform the matching of the Nominal Rolls with the NCSCH.

B.6.4.6 Search of Department of Immigration and Multicultural Affairs records of arrivals, departures and Passports

The Nominal Roll may be matched with Department of Immigration and Multicultural Affairs and Passports records. This will identify those veterans who are alive but living or travelling overseas.

B.6.4.7 Vietnam veteran and military unit organisations

The list of names of those not confirmed alive or dead through all the above searches may then be matched with membership and death lists maintained by Vietnam veteran and military unit organisations to identify vital statistics not obtainable from other sources. A death identified from these sources will require evidence of a death certificate for the purposes of the study.

Lists of the recently allocated National Service Commemorative Medal will also be accessed to identify any veterans not previously allocated.

B.6.4.8 Other potential sources of information

The feasibility of searching for information on vital statistics of Vietnam veterans from other sources, such as:

- police and corrective services records;
- New Zealand registry of Birth, Deaths & Marriages;
- White pages;
- manual follow-ups;

will be explored, if necessary.

B.6.4.9 Focus group analysis

Two to four focus groups will be conducted separately with Army and Navy crews. Six to twelve veterans will participate in each group. Topic areas for discussion, questions and prompts will be prepared prior to the focus group and the epidemiologist for the study will moderate the groups. Discussion will be audio taped and transcribed, with veterans' permission. Thematic analysis using hierarchical coding will be employed to assess trends and similarities in experiences, as well as factual information on water distillation equipment and procedures. Where available, archival documents will be obtained to confirm and supplement the information received through the focus groups.

B.7. Power of the study

Tables in Appendix 2 give the details of the power estimates for the study. The tables give the probability of detecting a significant increase in mortality for selected causes for the groups of interest compared to the Australian male

population. Several assumptions were made in the calculations. The ABS 2000 age standarised mortality rates for all males were used. The comparison group was all Australian males and a one-sided statistical test was used. The length of follow-up of 34 years and vital statistics for all participants were assumed.

The analysis shows that there is good statistical power to detect an increase in mortality for most conditions for all service branches. The power is less for rare diseases among RAAF personnel. For the 32 Small Ship Squadron there is significant power to detect increases in all cause mortality (for RR > 1.3) and all neoplasms if the relative risk is greater than 1.5. Power estimates on a ship-by-ship basis for RAN personnel shows that for those ships with greater than 650 crew, there is sufficient power to detect increase in mortality for all causes and all neoplasms.

The final table in Appendix 2 shows an example of power calculations for cancer incidence among Army veterans.

B.8. Data analysis

The data will be analysed by the epidemiologist at DVA in consultation with the AIHW and others as deemed necessary. Standard statistical analytical techniques will be employed. Mortality will be reported as Standardised Mortality Ratios (SMR) using the person-years method. The person-years method entails classifying deaths and the length of time each cohort member is alive ('person-time') during the period of observation into an age and calendar time grid. In this study, the degree of subdivision will correspond to 5-year age groups and five calendar years. The age and calendar year specific death rates for the cohort will be computed as the total number of deaths in the appropriate cell divided by the total person-time for that cell.

To compare the mortality in the cohort with the mortality in the national population, the number of expected deaths in each cell, based on national mortality rates, will be computed by multiplying the person-time in the cell by the national death rate for the corresponding 5 year age group and calendar years. Summing these expected deaths over the whole matrix gives the total number of deaths that would be expected in the cohort if the age- and year-specific mortality rates for the cohort were identical to those of the Australian male population.

The ratio of the total *observed* deaths in the cohort and the total *expected* deaths in the cohort is the *Standardised Mortality Ratio* (SMR), which is a measure of the relative mortality rate between the cohort and the reference population. An SMR greater than one indicates higher death rates in the cohort compared with the Australian male population, adjusted for age and calendar year. An SMR less than one reflects lower death rates in the cohort.

Death rates for specific causes of death will be calculated by counting only observed deaths with specific ICD-10 codes and basing the calculation of expected deaths on the corresponding national death rates for those ICD codes. Analysis will focus on causes of death identified in Table 1.4-1 as of *a priori* interest.

Cancer incidence, including the extension of the Dapsone study, will report results as relative cancer incidence rate (RR) between the exposed and non-exposed groups of interest.

In addition, deaths, cancer incidence, and person-year matrices will be further subdivided by service branch and for RAN personnel and members of the 32 Small Ship Squadron, by the ship in which they served. Poisson regression modelling will be used to investigate the estimated relative death rate for all causes among these subgroups. Poisson regression is the established method for analysis of cohort studies. It allows for analysis of a cohort with unequal periods of follow-up and controls for potential confounders, such as age, corps grouping, and length of service in Vietnam. Parameter estimates of incidence rates and 95% confidence intervals are readily obtained from the regression models

Several statistical packages will be used for the data management and analysis. Data will be initially managed on EXCEL and ACCESS spreadsheets. Initial processing and calculation of person-years will be performed in SPSS. Poisson and logistic regression modelling will be performed using STATA.

B.9. Study committees

Several committees will be established to oversee the study. These committees will comprise representatives of relevant stakeholders and expert advisers to ensure the study is inclusive and of the highest quality.

B.9.1. Consultative Forum

The consultative forum will keep a non-scientific watching brief on the study, report to the Repatriation Commission and consist of representatives from:

- Repatriation commission, Chair
- Minister's office
- Vietnam Veterans Association of Australia
- Vietnam Veterans' Federation
- Returned and Services League
- Australian Veterans and Defence Services Council (AVADSC)
- Naval Association of Australia
- Department of Veterans Affairs (5 members).

The consultative committee will meet:

- prior to commencing the study to approve membership of the other committees and study protocol;
- during the study to monitor overall progress; and
- at completion of the study to comment on the draft report.

A member of the Consultative Forum will be appointed to sit on the Scientific Advisory Committee.

B.9.2. Scientific Advisory Committee

The Scientific Advisory Committee, comprising experts in appropriate fields, will be the final arbiters of scientific matters in the conduct of the study. They will report to and meet:

- prior to commencing the study to approve the protocol;
- periodically during the study to monitor scientific progress; and
- after completion of the study to approve the presentation of the study findings.

A member of the Scientific Advisory Committee will be appointed to sit on the Consultative Forum.

B.9.3. Ethics committee and involvement of other organisations

The following Ethics Committees will review the study protocol and aspects of the its conduct:

- Medical Research Ethics Committee, Department of Veterans'Affairs will be responsible for providing ethical clearance for the conduct of the study;
- Ethics Committee, Australian Institute of Health and Welfare (AIHW), will be responsible for providing ethical clearance for the use of the National Death Index; and
- Ethics committees of individual states will be responsible for ethical clearance to cancer registries.

Other organisations that may be involved with this study are those that hold registers which the study staff would like to access for the names of Vietnam veterans. The organisations and registers include:

- Health Insurance Commission
- Department of Immigration and Multicultural Affairs
- Passports.

B.9.4. Project Team

The project team will comprise the following people:

- Dr Eileen Wilson – epidemiologist, DVA
- Dr Keith Horsley – director of research studies, DVA
- Ms Catherine Kinsella, secretariat, DVA
- Dr Paul Jelfs, AIHW
- Mr Robert van der Hoek, AIHW

- Other consultants as deemed necessary.

B.10. Reporting

Progress of the study will be reported to the Consultative Forum and the Scientific Advisory Committee at periodic meetings. The Consultative Forum will comment on and the Scientific Advisory Committee will approve and sign off on the draft of the final report prior to forwarding to the Repatriation Commission. The Repatriation Commission will provide the final report to the Minister for Veterans Affairs who will release the report to the public. No part of the study will be made public prior to Ministerial release.

After publication of the report, the study team will seek to publish key results in peer-reviewed scientific journals.

Privacy and confidentiality will be maintained at all times, in accordance with the aforementioned legislation, and no individuals will be identified in any reports.

B.11. Strengths and limitations of the study

This study will be a comprehensive mortality and cancer incidence study of Vietnam veterans. It will include all groups of veterans and make comparisons between several subgroups of veterans and non-veteran military and civilian populations. It will be the first time a cancer incidence study has been undertaken for Navy and RAAF Vietnam veterans. The study is being conducted 29 to 39 years following Vietnam service, which allows for sufficient time for many conditions with a long latency to develop.

As this study follows several earlier studies, the Project Team will be able to build on the information gained previously to enhance the present study. The Nominal Roll is complete and considered accurate and the data from the 1997 Mortality Study has been safely stored and is uncorrupted. That study collected mortality data to December 1994. The present study will add seven more years of data to this database and attempt to capture those for whom vital statistics could not be matched. The most recent cancer incidence study for this cohort was the 1992 Dapsone study, which collected data to December 1989 for 115,407 male Army personnel who served in Vietnam or Australia during the Vietnam conflict years. The present study will extend the data by 12 years and include Navy and Air Force personnel. The extension of the Dapsone study will correlate dapsone and malaria exposure to cancer incidence and mortality.

However as in other epidemiological studies, this study will only identify statistical associations, not causal associations, between exposure and disease. These statistical associations have a degree of imprecision as indicated by confidence intervals and the risk of cancer may be influenced by other factors not related to dapsone exposure or Vietnam service that are not measured in this study. These confounding factors, such as cigarette smoking, sunlight exposure or other lifestyle factors may mask any real association between dapsone exposure, Vietnam service, and mortality or cancer incidence.

Data matching techniques have improved in recent years and the researchers anticipate a reduction in the number of veterans lost to follow-up. Also the number of deaths among the cohort will have increased as the cohort ages. The combination of the increased number of deaths and reduced number lost to follow-up will increase the accuracy of the SMR estimates.

In past studies the 'healthy serviceman' effect of the Vietnam veterans, who were required to be fit for service, influenced the interpretation of the study results. This effect will have less influence on the data with the increased time of follow-up from Vietnam service. A more meaningful comparison will be able to be made between veterans and the general Australian population.

Table B.3: Reports on health issues for Australian Vietnam veterans

Study	Year	Type of Study	Results
"The Australian Veterans' Health Studies Mortality Report", Part I [1]	1984	With AIHW, ABS, Cohort study of National service vets (19,209) vs non-vets (26,957)	Data to 1982. Overall mortality lower than Australian population. No elevated mortality by corps grouping, nor elevated cancer deaths, nor any other categories. # deaths too small (523 total) and follow-up time too short for meaningful conclusions
"The Australian Veterans' Health Studies Mortality Report", Part II[2]	1984	Case-control study	Compared characteristics of deceased veterans with those of random sample of survivors. Poorer education and psychological health related to deceased. Engineering corps members had excess mortaltiy.
"The Australian Veterans' Health Studies Mortality Report", Part III[3]	1984	Descriptive risk analysis	Correlated the risk of becoming a combat casualty in Vietnam with location of service and subsequent mortality. Increased mortality with engineering corps. No association with locality and mortality

"Dapsone Exposure, Vietnam Service and Cancer Incidence"[4]	1992	Cohort study by AIHW of 115,407 Australian army	Looked at cancer incidence, did dose exposure comparisons and compared Malaria ±, No increase in overall cancer incidence for veterans
"Vietnam service, Dapsone Use and Cancer[5]	1994	AIHW, Female veterans (N = 46), cancer incidence & toxic reactions in male – case histories (N = 10)	Complemented larger Dapsone study. Numbers small but female showed elevated cancer incidence
"Mortality of Vietnam Veterans"[6]	1997	Cohort study of 59,036 veterans	Mortality study of death data to Dec 1994. Showed a number of increases esp, neoplasms, prostate & lung
"Mortality of National Service Vietnam Veterans"[7]	1997	Cohort study of 43,595 National service veterans and non-veterans	Comparison of mortality. Eliminated 'healthy worker' confounder. Elevated RR for all causes, lung & brain cancers, cirrhosis, diseases of digestive system.
"Morbidity of Vietnam Veterans" Male vol 1[8]	1998	Questionnaire survey	Self-reported data from 40,030 male Vets (80% response rate)
"Morbidity of Vietnam Veterans" Female vol 2 [9]	1998	Questionnaire survey	Self-reported data. Could only locate 278/484 female Vets on Nominal Roll but of those 81% completed questionnaire
"Morbidity of Vietnam Veterans: Validation study"[10]	1999	Validation of self-reported questionnaire survey	Found elevated rates of melanoma (483 cases, 380(342-418) expected)and prostate cancer (212 cases, 147 (123-171) expected)

"Morbidity of Vietnam veterans: Suicide in Vietnam veterans' children: Supplementary report no 1"[11]	2000	Validation of self-reported questionnaire survey	Found children of Vietnam veterans had suicide rate three times the expected rate for the general population.
"Morbidity of Vietnam veterans: Adrenal gland cancer, leukaema and non-Hodgkin's lymphoma: Supplementary report no. 2"[12]	2001	Validation of self-reported questionnaire survey	Adrenal cancer (10 cases, 1 (0-3) expected) and AML (9-18 cases, 3 (0-6) expected) incidence elevated in veterans' children. Non Hodgkin's lymphoma higher than expected in veterans (66 cases, 48 (34-62) expected). All other leukaemia not elevated in veterans or their children.
"Morbidity of Vietnam veterans. Multiple sclerosis and motor neurone disease in Vietnam veterans: Supplementary report no. 3"[13]	2001	Validation of self-reported questionnaire survey	MND elevated if include deaths in validation (3-5 cases, 1.2 (0-3.3) expected). No elevation of MS

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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.

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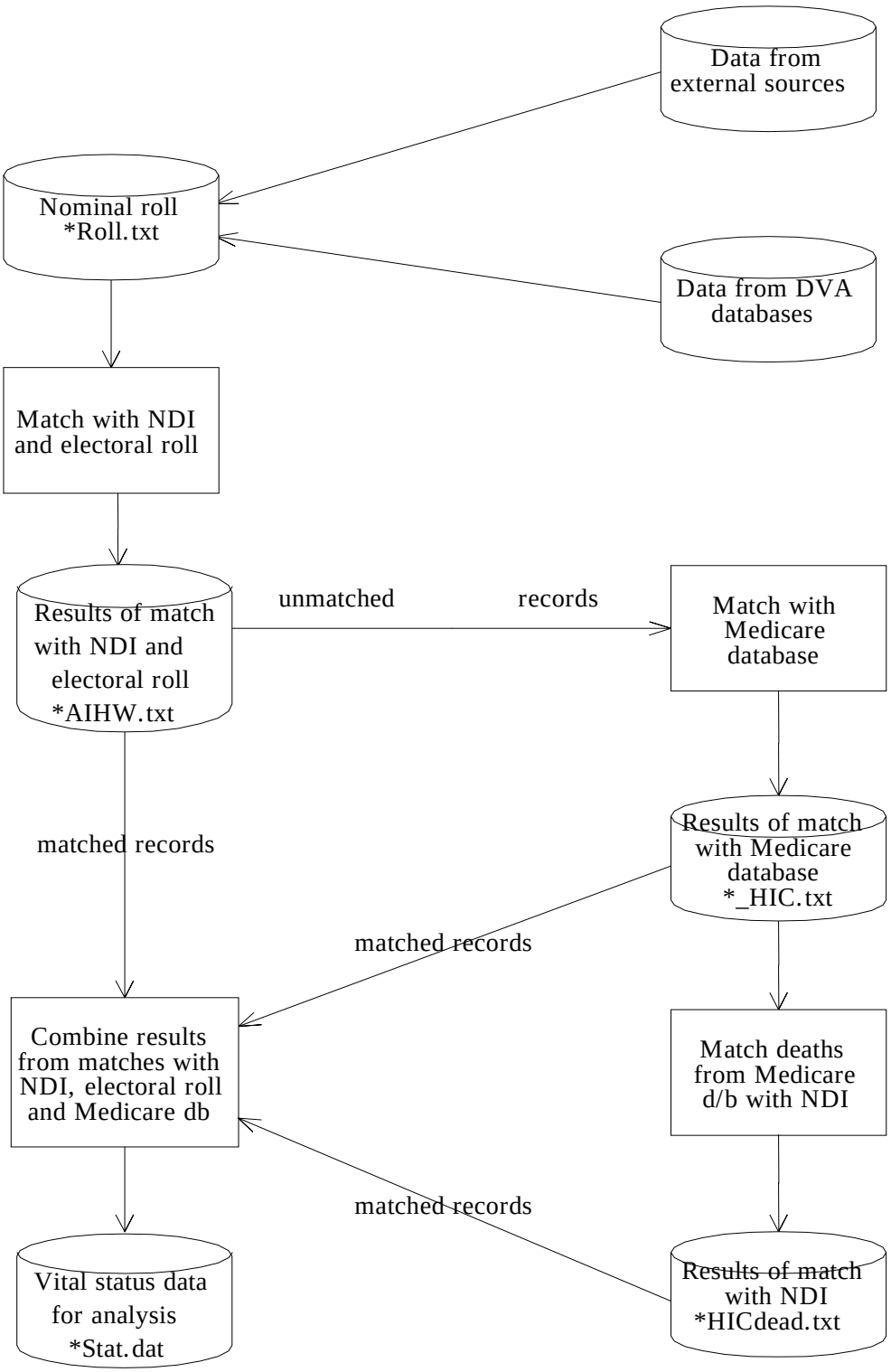
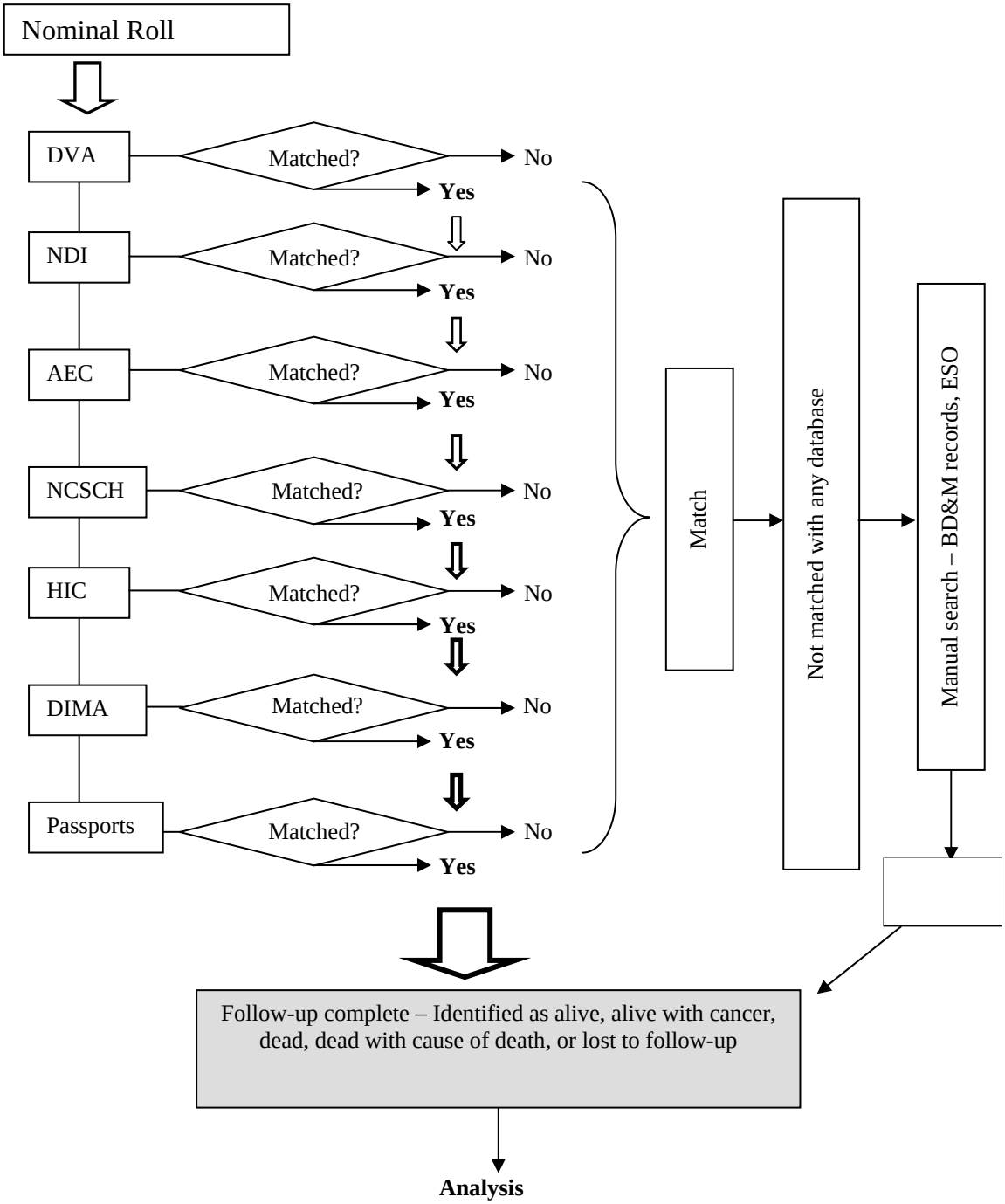
12. AIHW. Morbidity of Vietnam veterans: Adrenal gland cancer, leukaema and non-Hodgkin's lymphoma: Supplementary report no. 2. Canberra: Australian Institute of Health and Welfare, 2001.

13. AIHW. Morbidity of Vietnam veterans. Multiple sclerosis and motor neurone disease in Vietnam veterans: Supplementary report no. 3. Canberra: Australian Institute of Health and Welfare, 2001.

Study Protocol Appendix 1A: Previous matching protocol



Study Protocol Appendix 1B: Proposed matching protocol for Vietnam Veteran Mortality Study



The Nominal Roll will be matched simultaneously with the seven databases. Those not matched with any database will undergo manual searches with BD&M records and ex-service organisations records.

Study Protocol Appendix 2: Power calculations

Mortality

Army

National service

Navy

RAAF

32 Small Ship Squadron

Naval Units

Cancer Incidence

Army

Army

Estimated Power for Third Vietnam Veteran Mortality Study

Disease (ICD-10)	Standardised Death Rate[a]	% Probability of detecting changes in the relative risk of a given disease											
		Relative Risk (Ratio of change in disease incidence in study population)											
		1	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	2	2.2	2.4
All neoplasms (C00-D48)	215.4	5.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Malignant neoplasms (C00-C97)	211.2	5.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Lip, oral cavity and pharynx (ABS 1997)	4.9	5.0	20.2	47.5	75.0	91.7	98.0	99.7	100.0	100.0	100.0	100.0	100.0
Digestive organs (C15-C26)	59.3	5.0	88.5	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
pancreas (C25)	9.0	5.0	29.2	69.1	93.3	99.3	100.0	100.0	100.0	100.0	100.0	100.0	100.0
liver (C22)	5.3	5.0	21.1	50.0	77.9	93.4	98.7	99.8	100.0	100.0	100.0	100.0	100.0
Melanoma (C43)	6.4	5.0	23.6	56.5	84.3	96.5	99.5	100.0	100.0	100.0	100.0	100.0	100.0
Brain (C71)	6.3	5.0	23.4	55.9	83.8	96.3	99.5	100.0	100.0	100.0	100.0	100.0	100.0
Prostate (C61)	28.7	5.0	62.6	98.6	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Trachea, bronchus and lung (C33, C34)	48.0	5.0	81.8	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Lymphatic and haematopoietic (C81-C96)	21.6	5.0	52.4	95.4	99.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
leukaemia (C91-C95)	8.1	5.0	27.3	65.1	91.0	98.8	99.9	100.0	100.0	100.0	100.0	100.0	100.0
Benign and unspecified (D00-D48)	4.2	5.0	18.5	42.8	69.2	87.7	96.3	99.2	99.9	100.0	100.0	100.0	100.0
All disease of circulatory system (I00-I99)	254.3	5.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
ischaemic heart disease	182.3	5.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Cerebrovascular disease (I60-I69)	53.2	5.0	85.2	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Diseases of respiratory system (J00-J99)	64.0	5.0	90.5	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Diseases of digestive system (K00-K93)	21.5	5.0	52.2	95.3	99.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Diabetes (E10-E14)	16.9	5.0	44.5	90.3	99.6	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Diseases of nervous system (G00-G99)	19.7	5.0	49.3	93.8	99.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Accidents, poisoning and violence (V01-Y98)	58.4	5.0	88.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
All causes	710.1	5.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[a] For males per 100,000 per year. Source: Australian Bureau of Statistics, 2000.

Notes: Shaded area indicates where study power has less than 85% chance of detecting change in disease at the 0.05 level of significance

Assumptions:			
	Australian males	Number of individuals in comparison population (male)	9000000
	Army	Number of exposed participants in the study population	41388
		Length of time of follow-up of the study population (yrs)	34
		All participants traced	

National service

Estimated Power for Third Vietnam Veteran Mortality Study

Disease (ICD-10)	Standardised Death Rate[a]	% Probability of detecting changes in the relative risk of a given disease											
		Relative Risk (Ratio of change in disease incidence in study population)											
		1	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	2	2.2	2.4
All neoplasms (C00-D48)	215.4	5.0	88.5	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Malignant neoplasms (C00-C97)	211.2	5.0	87.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Lip, oral cavity and pharynx (ABS 1997)	4.9	5.0	10.9	20.1	32.2	46.0	59.7	71.9	81.7	88.8	96.5	99.1	99.8
Digestive organs (C15-C26)	59.3	5.0	42.3	88.3	99.4	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
pancreas (C25)	9.0	5.0	13.9	29.1	48.4	67.3	82.1	91.5	96.5	98.7	99.9	100.0	100.0
liver (C22)	5.3	5.0	11.2	21.0	33.9	48.4	62.6	74.9	84.3	90.8	97.4	99.4	99.9
Melanoma (C43)	6.4	5.0	12.0	23.5	38.5	54.8	69.7	81.6	89.8	94.8	98.9	99.8	100.0
Brain (C71)	6.3	5.0	12.0	23.3	38.1	54.2	69.2	81.0	89.3	94.5	98.8	99.8	100.0
Prostate (C61)	28.7	5.0	26.0	62.4	89.1	98.3	99.8	100.0	100.0	100.0	100.0	100.0	100.0
Trachea, bronchus and lung (C33, C34)	48.0	5.0	36.6	81.6	98.2	99.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Lymphatic and haematopoietic (C81-C96)	21.6	5.0	21.9	52.1	80.1	94.6	99.0	99.9	100.0	100.0	100.0	100.0	100.0
leukaemia CC91-C95)	8.1	5.0	13.3	27.2	45.1	63.4	78.5	88.8	94.9	97.9	99.7	100.0	100.0
Benign and unspecified (D00-D48)	4.2	5.0	10.3	18.4	29.1	41.5	54.2	66.1	76.2	84.2	94.0	98.1	99.5
All disease of circulatory system (I00-I99)	254.3	5.0	92.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
ischaemic heart disease	182.3	5.0	83.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Cerebrovascular disease (I60-I69)	53.2	5.0	39.2	85.0	98.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Diseases of respiratory system (J00-J99)	64.0	5.0	44.5	90.4	99.6	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Diseases of digestive system (K00-K93)	21.5	5.0	21.8	52.0	80.0	94.5	99.0	99.9	100.0	100.0	100.0	100.0	100.0
Diabetes (E10-E14)	16.9	5.0	19.0	44.3	71.1	89.1	97.0	99.4	99.9	100.0	100.0	100.0	100.0
Diseases of nervous system (G00-G99)	19.7	5.0	20.7	49.1	76.8	92.8	98.5	99.8	100.0	100.0	100.0	100.0	100.0
Accidents, poisoning and violence (V01-Y98)	58.4	5.0	41.8	87.8	99.3	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
All causes	710.1	5.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[a] For males per 100,000 per year. Source: Australian Bureau of Statistics, 2000.

Notes: Shaded area indicates where study power has less than 85% chance of detecting change in disease at the 0.05 level of significance

Assumptions:

NS non-vets*	Number of individuals in comparison population (male)	24646
NS vets*	Number of exposed participants in the study population	18949
	Length of time of follow-up of the study population (yrs)	34
	All participants traced	

*Excludes National service personnel who served less than one year

Navy

Estimated Power for Third Vietnam Veteran Mortality Study

Disease (ICD-10)	Standardised Death Rate[a]	% Probability of detecting changes in the relative risk of a given disease											
		Relative Risk (Ratio of change in disease incidence in study population)											
		1	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	2	2.2	2.4
All neoplasms (C00-D48)	215.4	5.0	92.1	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Malignant neoplasms (C00-C97)	211.2	5.0	91.6	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Lip, oral cavity and pharynx (ABS 1997)	4.9	5.0	11.5	21.8	35.4	50.5	65.0	77.2	86.3	92.3	98.1	99.6	99.9
Digestive organs (C15-C26)	59.3	5.0	46.5	91.9	99.8	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
pancreas (C25)	9.0	5.0	14.8	31.9	53.1	72.7	86.7	94.5	98.1	99.4	100.0	100.0	100.0
liver (C22)	5.3	5.0	11.8	22.8	37.3	53.2	68.0	80.0	88.5	93.9	98.7	99.8	100.0
Melanoma (C43)	6.4	5.0	12.7	25.6	42.4	59.9	75.1	86.2	93.1	96.9	99.5	99.9	100.0
Brain (C71)	6.3	5.0	12.7	25.4	41.9	59.3	74.5	85.7	92.8	96.7	99.5	99.9	100.0
Prostate (C61)	28.7	5.0	28.5	67.7	92.6	99.2	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Trachea, bronchus and lung (C33, C34)	48.0	5.0	40.2	86.2	99.1	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Lymphatic and haematopoietic (C81-C96)	21.6	5.0	23.8	57.1	84.9	96.8	99.6	100.0	100.0	100.0	100.0	100.0	100.0
leukaemia (C91-C95)	8.1	5.0	14.1	29.8	49.6	68.8	83.4	92.4	97.0	98.9	99.9	100.0	100.0
Benign and unspecified (D00-D48)	4.2	5.0	10.8	20.0	32.0	45.6	59.3	71.5	81.3	88.5	96.3	99.0	99.8
All disease of circulatory system (I00-I99)	254.3	5.0	95.5	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
ischaemic heart disease	182.3	5.0	87.5	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Cerebrovascular disease (I60-I69)	53.2	5.0	43.2	89.2	99.5	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Diseases of respiratory system (J00-J99)	64.0	5.0	49.0	93.6	99.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Diseases of digestive system (K00-K93)	21.5	5.0	23.8	56.9	84.7	96.7	99.6	100.0	100.0	100.0	100.0	100.0	100.0
Diabetes (E10-E14)	16.9	5.0	20.6	48.7	76.4	92.5	98.4	99.7	100.0	100.0	100.0	100.0	100.0
Diseases of nervous system (G00-G99)	19.7	5.0	22.5	53.8	81.9	95.5	99.3	99.9	100.0	100.0	100.0	100.0	100.0
Accidents, poisoning and violence (V01-Y98)	58.4	5.0	46.0	91.5	99.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
All causes	710.1	5.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[a] For males per 100,000 per year. Source: Australian Bureau of Statistics, 2000.

Notes: Shaded area indicates where study power has less than 85% chance of detecting change in disease at the 0.05 level of significance

Assumptions: Australian males — Number of individuals in comparison population (male) 9000000

Navy — Number of exposed participants in the study population 12376

Length of time of follow-up of the study population (yrs) 34

All participants traced

RAAF — Estimated Power for Third Vietnam Veteran Mortality Study

Disease (ICD-10)	Standardised Death Rate[a]	% Probability of detecting changes in the relative risk of a given disease											
		Relative Risk (Ratio of change in disease incidence in study population)											
		1	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	2	2.2	2.4
All neoplasms (C00-D48)	215.4	5.0	57.4	97.4	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Malignant neoplasms (C00-C97)	211.2	5.0	56.6	97.1	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Lip, oral cavity and pharynx (ABS 1997)	4.9	5.0	8.4	13.0	18.8	25.7	33.4	41.6	49.8	57.7	71.8	82.6	89.9
Digestive organs (C15-C26)	59.3	5.0	23.8	57.1	84.9	96.8	99.6	100.0	100.0	100.0	100.0	100.0	100.0
pancreas (C25)	9.0	5.0	9.9	17.3	27.0	38.3	50.2	61.7	71.9	80.3	91.5	96.8	99.0
liver (C22)	5.3	5.0	8.6	13.5	19.7	27.0	35.2	43.8	52.4	60.6	74.7	85.1	91.9
Melanoma (C43)	6.4	5.0	9.0	14.6	21.9	30.5	40.0	49.7	59.1	67.7	81.5	90.4	95.5
Brain (C71)	6.3	5.0	8.9	14.5	21.7	30.2	39.6	49.2	58.5	67.1	80.9	90.0	95.3
Prostate (C61)	28.7	5.0	15.9	35.1	58.2	78.0	90.6	96.7	99.0	99.8	100.0	100.0	100.0
Trachea, bronchus and lung (C33, C34)	48.0	5.0	21.0	49.7	77.6	93.2	98.6	99.8	100.0	100.0	100.0	100.0	100.0
Lymphatic and haematopoietic (C81-C96)	21.6	5.0	13.9	29.0	48.3	67.3	82.1	91.5	96.5	98.7	99.9	100.0	100.0
leukaemia CC91-C95)	8.1	5.0	9.6	16.4	25.3	35.7	46.8	57.8	67.9	76.5	88.8	95.3	98.3
Benign and unspecified (D00-D48)	4.2	5.0	8.1	12.2	17.4	23.4	30.2	37.5	44.9	52.3	66.0	77.2	85.6
All disease of circulatory system (I00-I99)	254.3	5.0	64.0	98.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
ischaemic heart disease	182.3	5.0	51.1	94.9	99.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Cerebrovascular disease (I60-I69)	53.2	5.0	22.3	53.2	81.3	95.2	99.2	99.9	100.0	100.0	100.0	100.0	100.0
Diseases of respiratory system (J00-J99)	64.0	5.0	25.0	59.9	87.3	97.7	99.8	100.0	100.0	100.0	100.0	100.0	100.0
Diseases of digestive system (K00-K93)	21.5	5.0	13.8	29.0	48.2	67.1	81.9	91.4	96.4	98.7	99.9	100.0	100.0
Diabetes (E10-E14)	16.9	5.0	12.5	24.9	41.0	58.1	73.3	84.7	92.1	96.3	99.4	99.9	100.0
Diseases of nervous system (G00-G99)	19.7	5.0	13.3	27.4	45.5	63.8	78.9	89.2	95.1	98.0	99.8	100.0	100.0
Accidents, poisoning and violence (V01-Y98)	58.4	5.0	23.6	56.5	84.4	96.6	99.5	100.0	100.0	100.0	100.0	100.0	100.0
All causes	710.1	5.0	98.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[a] For males per 100,000 per year. Source: Australian Bureau of Statistics, 2000.

Notes: Shaded area indicates where study power has less than 85% chance of detecting change in disease at the 0.05 level of significance

Assumptions:			
	Australian males	Number of individuals in comparison population (male)	9000000
	RAAF	Number of exposed participants in the study population	4438
		Length of time of follow-up of the study population (yrs)	34
		All participants traced	

Small Ships SQD — Estimated Power for Third Vietnam Veteran Mortality Study

Disease (ICD-10)	Standardised Death Rate[a]	% Probability of detecting changes in the relative risk of a given disease											
		Relative Risk (Ratio of change in disease incidence in study population)											
		1	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	2	2.2	2.4
All neoplasms (C00-D48)	215.4	5.0	16.5	37.0	61.3	81.1	92.7	97.8	99.5	99.9	100.0	100.0	100.0
Malignant neoplasms (C00-C97)	211.2	5.0	16.3	36.5	60.5	80.3	92.2	97.6	99.4	99.9	100.0	100.0	100.0
Lip, oral cavity and pharynx (ABS 1997)	4.9	5.0	6.1	7.3	8.6	10.0	11.5	13.1	14.8	16.6	20.3	24.2	28.3
Digestive organs (C15-C26)	59.3	5.0	9.6	16.4	25.3	35.8	47.0	58.1	68.2	76.8	89.0	95.5	98.4
pancreas (C25)	9.0	5.0	6.5	8.3	10.3	12.5	14.9	17.5	20.3	23.3	29.5	35.9	42.4
liver (C22)	5.3	5.0	6.1	7.4	8.8	10.3	11.9	13.6	15.4	17.3	21.3	25.4	29.8
Melanoma (C43)	6.4	5.0	6.3	7.7	9.2	11.0	12.8	14.8	16.9	19.1	23.8	28.7	33.7
Brain (C71)	6.3	5.0	6.2	7.6	9.2	10.9	12.7	14.7	16.8	18.9	23.5	28.4	33.4
Prostate (C61)	28.7	5.0	7.9	11.8	16.7	22.4	28.8	35.6	42.8	49.9	63.3	74.6	83.3
Trachea, bronchus and lung (C33, C34)	48.0	5.0	9.0	14.8	22.2	31.0	40.7	50.6	60.1	68.7	82.5	91.2	96.0
Lymphatic and haematopoietic (C81-C96)	21.6	5.0	7.5	10.7	14.5	19.0	24.0	29.5	35.3	41.2	52.9	63.7	73.1
leukaemia CC91-C95)	8.1	5.0	6.4	8.1	9.9	12.0	14.2	16.6	19.2	21.9	27.5	33.5	39.5
Benign and unspecified (D00-D48)	4.2	5.0	6.0	7.1	8.3	9.5	10.9	12.3	13.8	15.4	18.6	22.1	25.7
All disease of circulatory system (I00-I99)	254.3	5.0	18.1	41.8	68.1	86.9	96.0	99.1	99.8	100.0	100.0	100.0	100.0
ischaemic heart disease	182.3	5.0	15.1	32.8	54.7	74.6	88.2	95.5	98.5	99.6	100.0	100.0	100.0
Cerebrovascular disease (I60-I69)	53.2	5.0	9.3	15.6	23.7	33.3	43.7	54.1	64.0	72.7	85.8	93.5	97.4
Diseases of respiratory system (J00-J99)	64.0	5.0	9.9	17.1	26.6	37.7	49.5	60.9	71.1	79.6	91.1	96.7	98.9
Diseases of digestive system (K00-K93)	21.5	5.0	7.5	10.6	14.5	19.0	24.0	29.4	35.1	41.0	52.7	63.6	72.9
Diabetes (E10-E14)	16.9	5.0	7.2	9.8	13.0	16.7	20.8	25.2	30.0	34.9	44.9	54.7	63.7
Diseases of nervous system (G00-G99)	19.7	5.0	7.4	10.3	13.9	18.1	22.7	27.8	33.1	38.7	49.8	60.3	69.6
Accidents, poisoning and violence (V01-Y98)	58.4	5.0	9.6	16.3	25.1	35.4	46.5	57.5	67.6	76.2	88.6	95.3	98.3
All causes	710.1	5.0	38.6	84.7	98.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[a] For males per 100,000 per year. Source: Australian Bureau of Statistics, 2000.

Notes: Shaded area indicates where study power has less than 85% chance of detecting change in disease at the 0.05 level of significance

Assumptions: Australian males — Number of individuals in comparison population (male) 9000000

Small Ships — Number of exposed participants in the study population 596

Length of time of follow-up of the study population (yrs) 34

All participants traced

Naval Units — Estimated Power for Third Vietnam Veteran Mortality Study

Naval Unit	Number of personnel	RR for > 85% Power Mortality all causes (all neoplasms)	Merchant seamen	Total personnel	RR for > 85% Power Mortality all causes (all neoplasms)
BAND	20	2.3 (> 3.0)			
CDT3	49	1.8 (2.9)			
HELICOPTER FLIGHT VIETNAM	196	1.4 (1.8)			
HMAS *Anzac*	243	1.4 (1.8)			
HMAS *Boonaroo*	37	1.9 (> 3.0)	36	73	1.7 (2.5)
HMAS *Brisbane*	656	1.2 (1.5)			
HMAS *Derwent*	699	1.2 (1.4)			
HMAS *Duchess*	1,101	1.2 (1.4)			
HMAS *Hobart*	909	1.2 (1.4)			
HMAS *Jeparit*	139	1.5 (2.0)	239	378	1.3 (1.6)
HMAS *Melbourne*	1,492	1.2 (1.3)			
HMAS *Parramatta*	699	1.2 (1.4)			
HMAS *Perth*	861	1.2 (1.4)			
HMAS *Queenborough*	141	1.5 (2.0)			
HMAS *Quiberon*	148	1.5 (2.0)			
HMAS *Stuart*	318	1.3 (1.7)			
HMAS *Swan*	259	1.4 (1.7)			
HMAS *Sydney*	5,258	1.1 (1.2)			
HMAS *Torrens*	253	1.4 (1.7)			
HMAS *Vampire*	1,216	1.2 (1.3)			
HMAS *Vendetta*	989	1.2 (1.3)			
HMAS *Yarra*	818	1.2 (1.4)			
HQ AUSTRALIAN FORCE VIETNAM	14	2.5 (> 3.0)			
NO 9 SQN RAAF	7	> 3.0 (> 3.0)			
VISIT	355	1.3 (1.6)			
Total	*16,877*		*275*	*451*	

Notes: Assumptions: Vital Statistics available for all personnel; 34 years follow-up; Australian males comparison group; and ABS 2000 male standardised mortality rate

Army

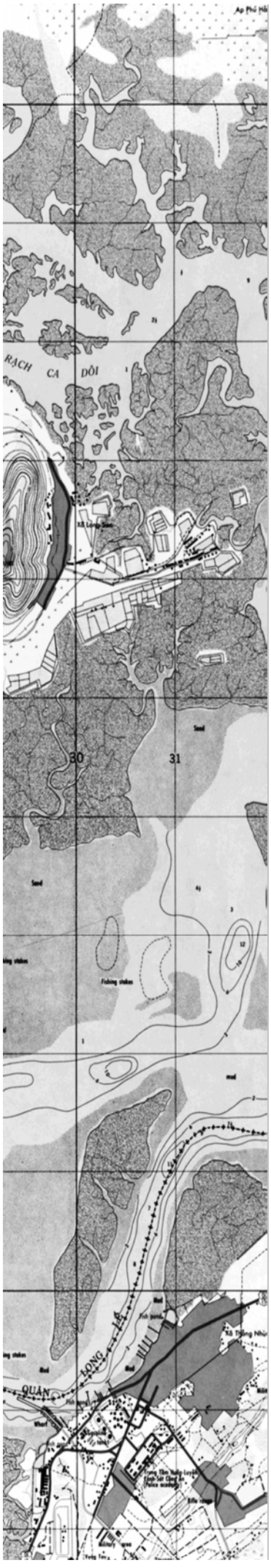
Power Calculations for Cancer Incidence

Disease (ICD-10)		Standardised Incidence	% Probability of detecting changes in the relative risk of a given disease							
			Relative Risk (Ratio of change in disease incidence in study population)							
			1	1.1	1.2	1.3	1.4	1.5	1.6	2
All neoplasms (C00-D48)	34.7	467.8	5.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Lung	6.9	56.9	5.0	87.3	100.0	100.0	100.0	100.0	100.0	100.0
Colorectal	182.3	65.8	5.0	91.2	100.0	100.0	100.0	100.0	100.0	100.0
Bladder	2.8	22.2	5.0	53.3	95.8	100.0	100.0	100.0	100.0	100.0
Pancreas (C25)	58.6	9.2	5.0	29.6	70.0	93.8	99.4	100.0	100.0	100.0
Kidney	9.5	14.3	5.0	39.7	85.6	99.0	100.0	100.0	100.0	100.0
Melanoma (C43)	2.4	47.2	5.0	81.2	100.0	100.0	100.0	100.0	100.0	100.0
Brain (C71)	8.1	7.5	5.0	26.0	62.3	89.0	98.2	99.8	100.0	100.0
Prostate (C61)	59.7	105.9	5.0	98.6	100.0	100.0	100.0	100.0	100.0	100.0
Non-Hodgkins	37.4	18.7	5.0	47.6	92.7	99.8	100.0	100.0	100.0	100.0
leukaemia CC91-C95)	28.5	13.0	5.0	37.3	82.5	98.4	100.0	100.0	100.0	100.0
Stomach	4.9	13.3	5.0	37.8	83.3	98.5	100.0	100.0	100.0	100.0

[a] For males per 100,000 per year. Source: Australian Bureau of Statistics, 2000.

Notes: Shaded area indicates where study power has less than 85% chance of detecting change in disease at the 0.05 level of significance

Assumptions:			
	Australia	Number of individuals in comparison population (male)	9000000
	Army	Number of exposed participants in the study population	41388
		Length of time of follow-up of the study population (years)	34
		All participants traced	



C

Tables of Results

Appendix C Tables of Results

Table C.1: National Servicemen: Observed and expected numbers of deaths, and standardised mortality ratios (SMR)

		Scenario 1 (excluding veterans whose status is unknown)			Scenario 2 (including veterans whose status is unknown)			
Cause of death	**Obs**	**Expected**	**SMR**	**95% CI**	**Expected**	**SMR**	**95% CI**	**Period**
All deaths	2,141	2,931	0.73	0.70–0.76	3,013	0.71	0.68–0.74	1966-2001
Infectious and parasitic diseases excluding Aids	11	28	0.39	0.19–0.70	29	0.38	0.19–0.68	1966-2001
Aids	37	43	0.86	0.59–1.14	45	0.84	0.57–1.11	1988-2001
Tuberculosis	0	2	0.00	0.00–1.85	2	0.00	0.00–1.80	1966-2001
Neoplasms	617	737	0.84	0.77–0.90	759	0.81	0.75–0.88	1966-2001
Blood & blood organs	6	6	0.96	0.35–2.06	7	0.93	0.34–2.01	1968-2001
Endocrine, nutritional and metabolic diseases	32	64	0.50	0.33–0.68	66	0.49	0.32–0.66	1966-2001
Diabetes	16	41	0.39	0.22–0.63	42	0.38	0.22–0.62	1966-2001
Mental disorders	19	46	0.42	0.25–0.64	47	0.41	0.24–0.63	1968-2001
Nervous system	26	62	0.42	0.26–0.59	64	0.41	0.25–0.57	1968-2001
Multiple sclerosis	2	5	0.44	0.05–1.58	5	0.43	0.05–1.54	1966-2001
Motor neurone	9	10	0.88	0.40–1.65	11	0.86	0.39–1.61	1966-2001
Eye diseases	0	0	–	–	0	–	–	1966-2001
Ear diseases	0	0	0.00	0.0–12.49	0	0.00	0.0–12.18	1966-2001
Circulatory system	465	647	0.72	0.65–0.78	666	0.70	0.63–0.76	1966-2001
Ischaemic	335	432	0.78	0.69–0.86	444	0.75	0.67–0.83	1966-2001
Cerebrovascular	48	86	0.55	0.40–0.71	88	0.54	0.39–0.69	1966-2001
Respiratory system	38	85	0.45	0.31–0.59	88	0.44	0.30–0.58	1966-2001
Asbestosis	0	0	0.00	0.0–16.89	0	0.00	0.0–16.39	1979-2001
COPD	18	20	0.92	0.54–1.44	20	0.89	0.52–1.40	1979-2001
Respiratory excluding COPD	20	50	0.40	0.23–0.58	51	0.39	0.22–0.56	1979-2001
Digestive system	92	131	0.70	0.56–0.85	135	0.68	0.54–0.82	1968-2001
Liver, gall bladder and bile ducts	78	101	0.77	0.60–0.95	103	0.75	0.59–0.92	1968-2001
Alcoholic liver	59	72	0.82	0.61–1.02	74	0.79	0.59–1.00	1968-2001
Peptic ulcer	1	6	0.16	0.00–0.88	7	0.15	0.00–0.85	1968-2001
Skin and subcutaneous tissue	1	2	0.61	0.02–3.35	2	0.59	0.01–3.25	1968-2001
Musculoskeletal system	6	6	1.02	0.37–2.19	6	0.99	0.36–2.13	1968-2001
Genitourinary system	6	15	0.40	0.15–0.86	16	0.39	0.14–0.84	1968-2001
Congenital malformation	2	17	0.12	0.01–0.42	18	0.11	0.01–0.41	1968-2001
Ill defined	11	19	0.58	0.29–1.02	20	0.56	0.28–1.00	1968-2001
External chapter	769	1015	0.76	0.70–0.81	1,042	0.74	0.69–0.79	1966-2001
Assault	12	42	0.29	0.15–0.50	43	0.28	0.14–0.49	1966-2001
Motor vehicle accidents	291	404	0.72	0.64–0.80	414	0.70	0.62–0.78	1966-2001
Suicide	260	298	0.87	0.76–0.98	306	0.85	0.74–0.95	1966-2001
Firearms	81	82	0.99	0.77–1.20	85	0.96	0.75–1.17	1966-2001
Gas and vapours	82	75	1.10	0.86–1.33	77	1.07	0.84–1.30	1966-2001
Hanging	43	55	0.78	0.55–1.02	57	0.76	0.54–0.99	1966-2001

Table C.2: National Servicemen, veterans: Observed and expected numbers of deaths, and standardised mortality ratios (SMR)

		Scenario 1 (excluding veterans whose status is unknown)			Scenario 2 (including veterans whose status is unknown)			
Cause of death	**Obs**	**Expected**	**SMR**	**95% CI**	**Expected**	**SMR**	**95% CI**	**Period**
All deaths	1,052	1,296	0.81	0.76–0.86	1,319	0.80	0.75–0.85	1966-2001
Infectious and parasitic diseases excluding Aids	7	12	0.57	0.23–1.16	13	0.56	0.22–1.14	1966-2001
Aids	17	19	0.91	0.52–1.43	19	0.89	0.51–1.40	1988-2001
Tuberculosis	0	1	0.00	0.00–4.18	1	0.00	0.00–4.11	1966-2001
Neoplasms	296	326	0.91	0.80–1.01	332	0.89	0.79–0.99	1966-2001
Blood & blood organs	2	3	0.73	0.09–2.58	3	0.72	0.08–2.54	1968-2001
Endocrine, nutritional and metabolic diseases	14	29	0.50	0.27–0.82	29	0.49	0.26–0.81	1966-2001
Diabetes	6	18	0.34	0.12–0.72	18	0.33	0.12–0.71	1966-2001
Mental disorders	13	20	0.66	0.34–1.10	20	0.65	0.34–1.08	1968-2001
Nervous system	13	27	0.48	0.25–0.81	28	0.47	0.25–0.80	1968-2001
Multiple sclerosis	0	2	0.00	0.00–1.83	2	0.00	0.00–1.80	1966-2001
Motor neurone	7	5	1.57	0.62–3.16	5	1.54	0.61–3.10	1966-2001
Eye diseases	0	0	–	–	0	–	–	1966-2001
Ear diseases	0	0	0.00	0.0–28.95	0	0.00	0.0–28.52	1966-2001
Circulatory system	212	287	0.74	0.64–0.84	292	0.73	0.63–0.83	1966-2001
Ischaemic	162	191	0.85	0.72–0.98	195	0.83	0.71–0.96	1966-2001
Cerebrovascular	15	38	0.40	0.22–0.65	39	0.40	0.22–0.64	1966-2001
Respiratory system	18	38	0.49	0.28–0.75	38	0.48	0.28–0.74	1966-2001
Asbestosis	0	0	0.00	0.0–38.27	0	0.00	0.0–37.52	1979-2001
COPD	8	9	0.94	0.41–1.81	9	0.92	0.40–1.77	1979-2001
Respiratory excluding COPD	10	22	0.46	0.22–0.83	23	0.45	0.21–0.82	1979-2001
Digestive system	59	58	1.02	0.76–1.28	59	1.00	0.75–1.26	1968-2001
Liver, gall bladder and bile ducts	52	44	1.17	0.85–1.49	45	1.15	0.84–1.46	1968-2001
Alcoholic liver	40	32	1.25	0.86–1.64	32	1.23	0.85–1.61	1968-2001
Peptic ulcer	0	3	0.00	0.00–1.31	3	0.00	0.00–1.29	1968-2001
Skin and subcutaneous tissue	1	1	1.38	0.03–7.53	1	1.35	0.03–7.39	1968-2001
Musculoskeletal system	2	3	0.77	0.09–2.73	3	0.76	0.09–2.68	1968-2001
Genitourinary system	3	7	0.45	0.09–1.30	7	0.45	0.09–1.28	1968-2001
Congenital malformation	0	8	0.00	0.00–0.49	8	0.00	0.00–0.48	1968-2001
Ill defined	6	8	0.72	0.26–1.54	9	0.71	0.26–1.51	1968-2001
External chapter	386	449	0.86	0.77–0.95	456	0.85	0.76–0.93	1966-2001
Assault	7	19	0.39	0.15–0.78	19	0.38	0.15–0.76	1966-2001
Motor vehicle accidents	140	179	0.78	0.65–0.91	182	0.77	0.64–0.90	1966-2001
Suicide	135	132	1.03	0.85–1.20	134	1.01	0.84–1.18	1966-2001
Firearms	49	36	1.34	0.97–1.72	37	1.32	0.95–1.69	1966-2001
Gas and vapours	41	33	1.24	0.86–1.62	34	1.22	0.84–1.59	1966-2001
Hanging	26	24	1.05	0.64–1.45	25	1.03	0.63–1.43	1966-2001

Table C.3: National Servicemen, non-veterans: Observed and expected numbers of deaths, and standardised mortality ratios (SMR)

		Scenario 1 (excluding veterans whose status is unknown)			Scenario 2 (including veterans whose status is unknown)			
Cause of death	**Obs**	**Expected**	**SMR**	**95% CI**	**Expected**	**SMR**	**95% CI**	**Period**
All deaths	1,089	1,634	0.67	0.63–0.71	1,694	0.64	0.60–0.68	1966-2001
Infectious and parasitic diseases excluding Aids	4	16	0.26	0.07–0.65	16	0.25	0.07–0.63	1966-2001
Aids	20	24	0.82	0.46–1.19	25	0.80	0.45–1.14	1988-2001
Tuberculosis	0	1	0.00	0.00–3.33	1	0.00	0.00–3.21	1966-2001
Neoplasms	320	411	0.78	0.69–0.86	426	0.75	0.67–0.83	1966-2001
Blood & blood organs	4	4	1.14	0.31–2.90	4	1.10	0.30–2.80	1968-2001
Endocrine, nutritional and metabolic diseases	18	36	0.50	0.30–0.79	37	0.49	0.29–0.77	1966-2001
Diabetes	10	23	0.44	0.21–0.81	24	0.42	0.20–0.78	1966-2001
Mental disorders	6	26	0.23	0.08–0.50	27	0.22	0.08–0.49	1968-2001
Nervous system	13	35	0.38	0.20–0.64	36	0.36	0.19–0.62	1968-2001
Multiple sclerosis	2	3	0.79	0.09–2.84	3	0.76	0.09–2.74	1966-2001
Motor neurone	2	6	0.35	0.04–1.25	6	0.33	0.04–1.21	1966-2001
Eye diseases	0	0	–	–	0	–	–	1966-2001
Ear diseases	0	0	0.00	0.0–21.96	0	0.00	0.0–21.27	1966-2001
Circulatory system	252	361	0.70	0.61–0.79	374	0.67	0.59–0.76	1966-2001
Ischaemic	172	240	0.72	0.61–0.82	249	0.69	0.59–0.79	1966-2001
Cerebrovascular	32	48	0.67	0.44–0.90	50	0.65	0.42–0.87	1966-2001
Respiratory system	20	47	0.42	0.24–0.61	49	0.41	0.23–0.59	1966-2001
Asbestosis	0	0	0.00	0.0–30.22	0	0.00	0.0–29.10	1979-2001
COPD	10	11	0.91	0.43–1.67	11	0.87	0.42–1.61	1979-2001
Respiratory excluding COPD	10	28	0.36	0.17–0.66	29	0.35	0.17–0.63	1979-2001
Digestive system	33	73	0.45	0.30–0.61	76	0.44	0.29–0.59	1968-2001
Liver, gall bladder and bile ducts	26	56	0.46	0.29–0.64	58	0.45	0.28–0.62	1968-2001
Alcoholic liver	19	40	0.47	0.29–0.74	42	0.46	0.28–0.71	1968-2001
Peptic ulcer	1	4	0.28	0.01–1.57	4	0.27	0.01–1.52	1968-2001
Skin and subcutaneous tissue	0	1	0.00	0.00–3.99	1	0.00	0.00–3.85	1968-2001
Musculoskeletal system	4	3	1.21	0.33–3.10	3	1.17	0.32–2.99	1968-2001
Genitourinary system	3	8	0.36	0.07–1.05	9	0.35	0.07–1.01	1968-2001
Congenital malformation	2	10	0.21	0.03–0.75	10	0.20	0.02–0.73	1968-2001
Ill defined	5	11	0.47	0.15–1.09	11	0.45	0.15–1.05	1968-2001
External chapter	383	566	0.68	0.61–0.74	586	0.65	0.59–0.72	1966-2001
Assault	5	23	0.21	0.07–0.50	24	0.21	0.07–0.48	1966-2001
Motor vehicle accidents	151	225	0.67	0.56–0.78	233	0.65	0.55–0.75	1966-2001
Suicide	125	167	0.75	0.62–0.88	173	0.72	0.60–0.85	1966-2001
Firearms	33	46	0.71	0.47–0.95	48	0.68	0.45–0.92	1966-2001
Gas and vapours	41	42	0.98	0.68–1.28	43	0.95	0.66–1.24	1966-2001
Hanging	18	31	0.58	0.34–0.91	32	0.56	0.33–0.88	1966-2001

Table C.4: National Servicemen: Observed and expected numbers of cancers and the standardised incidence ratios (SIR), 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	1,724	1,787	0.96	0.92–1.01	1,839	0.94	0.89–0.98
Brain and CNS	45	55	0.82	0.58–1.06	57	0.80	0.56–1.03
Breast	2	4	0.57	0.07–2.04	4	0.55	0.07–1.98
Connective soft tissue	23	22	1.06	0.63–1.50	22	1.03	0.61–1.46
Eye	19	9	2.08	1.25–3.25	9	2.02	1.22–3.16
Gastrointestinal	266	291	0.91	0.80–1.02	300	0.89	0.78–0.99
Colorectal	219	235	0.93	0.81–1.06	241	0.91	0.79–1.03
Colon	126	131	0.96	0.79–1.13	135	0.94	0.77–1.10
Rectum	89	99	0.90	0.71–1.09	102	0.88	0.69–1.06
Stomach	36	49	0.73	0.49–0.97	51	0.71	0.48–0.94
Genitourinary	313	311	1.01	0.90–1.12	320	0.98	0.87–1.09
Bladder	58	59	0.99	0.73–1.24	60	0.96	0.71–1.21
Kidney	60	66	0.91	0.68–1.14	68	0.89	0.66–1.11
Prostate	144	122	1.18	0.99–1.38	125	1.15	0.96–1.34
Testis	44	54	0.82	0.58–1.06	55	0.80	0.56–1.03
Hodgkin's disease	30	19	1.61	1.03–2.18	19	1.56	1.00–2.12
Leukaemia	50	56	0.89	0.65–1.14	58	0.87	0.63–1.11
Lymphoid	23	25	0.92	0.55–1.30	26	0.90	0.53–1.27
LL_acute	1	5	0.21	0.01–1.15	5	0.20	0.01–1.12
LL_chronic	19	15	1.24	0.75–1.94	16	1.21	0.73–1.89
Myeloid leukaemia	25	29	0.87	0.53–1.21	30	0.84	0.51–1.17
ML_acute	16	15	1.07	0.61–1.74	15	1.04	0.60–1.70
ML_chronic	7	11	0.66	0.26–1.35	11	0.64	0.26–1.32
Liver	3	16	0.19	0.04–0.55	16	0.18	0.04–0.53
Lung	121	143	0.84	0.69–0.99	148	0.82	0.67–0.97
Adenocarcinoma	40	45	0.89	0.61–1.16	46	0.86	0.59–1.13
Squamous	24	30	0.81	0.49–1.13	31	0.79	0.47–1.10
Small-cell	23	22	1.02	0.60–1.44	23	0.99	0.59–1.40
Large-cell	17	27	0.63	0.37–1.01	28	0.61	0.36–0.98
Other	17	19	0.89	0.52–1.42	20	0.86	0.50–1.38
Melanoma	435	370	1.18	1.07–1.29	381	1.14	1.04–1.25
Mesothelioma	12	14	0.88	0.45–1.53	14	0.85	0.44–1.49
Multiple myeloma	19	21	0.91	0.55–1.43	21	0.89	0.53–1.39
NHL	74	110	0.67	0.52–0.82	113	0.65	0.50–0.80
Oesophagus	15	23	0.66	0.37–1.09	23	0.64	0.36–1.06
Oropharynx and larynx	96	109	0.88	0.71–1.06	112	0.86	0.69–1.03
Head and neck	72	84	0.86	0.66–1.06	86	0.84	0.64–1.03
Larynx	24	25	0.96	0.57–1.34	26	0.93	0.56–1.30
Pancreas	26	30	0.86	0.53–1.19	31	0.84	0.51–1.16
Thyroid	13	20	0.64	0.34–1.10	21	0.63	0.33–1.07
Unknown primary	44	53	0.83	0.58–1.07	55	0.81	0.57–1.04

Table C.5: National Servicemen, veterans: Observed and expected numbers of cancers and the standardised incidence ratios (SIR), 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	810	791	1.02	0.95–1.09	806	1.01	0.94–1.07
Brain and CNS	23	24	0.95	0.56–1.33	25	0.93	0.55–1.31
Breast	0	2	0.00	0.00–2.37	2	0.00	0.00–2.33
Connective soft tissue	10	10	1.05	0.50–1.92	10	1.03	0.49–1.89
Eye	11	4	2.72	1.36–4.86	4	2.67	1.33–4.77
Gastrointestinal	121	129	0.94	0.77–1.10	132	0.92	0.76–1.08
Colorectal	103	104	0.99	0.80–1.18	106	0.97	0.78–1.16
Colon	54	58	0.93	0.68–1.18	59	0.91	0.67–1.16
Rectum	46	44	1.05	0.75–1.35	45	1.03	0.73–1.33
Stomach	11	22	0.50	0.25–0.90	22	0.49	0.25–0.88
Genitourinary	124	138	0.90	0.74–1.06	140	0.88	0.73–1.04
Bladder	19	26	0.73	0.44–1.14	27	0.72	0.43–1.12
Kidney	19	29	0.65	0.39–1.02	30	0.64	0.39–1.00
Prostate	65	54	1.20	0.91–1.50	55	1.18	0.89–1.47
Testis	17	24	0.72	0.42–1.15	24	0.71	0.41–1.14
Hodgkin's disease	12	8	1.46	0.75–2.55	8	1.43	0.74–2.50
Leukaemia	16	25	0.65	0.37–1.05	25	0.63	0.36–1.03
Lymphoid	9	11	0.82	0.37–1.55	11	0.80	0.37–1.53
LL_acute	0	2	0.00	0.00–1.74	2	0.00	0.00–1.71
LL_chronic	8	7	1.18	0.52–2.33	7	1.16	0.51–2.28
Myeloid leukaemia	7	13	0.55	0.22–1.13	13	0.54	0.22–1.11
ML_acute	3	7	0.45	0.09–1.33	7	0.45	0.09–1.30
ML_chronic	3	5	0.64	0.13–1.86	5	0.63	0.13–1.83
Liver	2	7	0.28	0.03–1.03	7	0.28	0.03–1.01
Lung	78	64	1.23	0.95–1.50	65	1.20	0.94–1.47
Adenocarcinoma	27	20	1.35	0.84–1.86	20	1.32	0.82–1.82
Squamous	19	13	1.45	0.87–2.27	13	1.43	0.86–2.23
Small-cell	14	10	1.40	0.76–2.35	10	1.37	0.75–2.30
Large-cell	8	12	0.67	0.30–1.31	12	0.65	0.29–1.29
Other	10	9	1.18	0.56–2.16	9	1.15	0.55–2.12
Melanoma	204	163	1.25	1.08–1.42	166	1.23	1.06–1.39
Mesothelioma	8	6	1.31	0.58–2.59	6	1.29	0.57–2.54
Multiple myeloma	8	9	0.87	0.38–1.71	9	0.85	0.38–1.68
NHL	35	49	0.72	0.48–0.95	50	0.70	0.47–0.94
Oesophagus	9	10	0.90	0.41–1.70	10	0.88	0.40–1.67
Oropharynx and larynx	52	48	1.08	0.78–1.37	49	1.06	0.77–1.34
Head and neck	44	37	1.18	0.83–1.53	38	1.16	0.82–1.51
Larynx	8	11	0.72	0.32–1.41	11	0.70	0.31–1.39
Pancreas	17	13	1.27	0.74–2.03	14	1.24	0.72–1.99
Thyroid	4	9	0.45	0.12–1.15	9	0.44	0.12–1.13
Unknown primary	21	24	0.89	0.51–1.27	24	0.88	0.50–1.25

Table C.6: National Servicemen, non-veterans: Observed and expected numbers of cancers and the standardised incidence ratios (SIR), 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	914	996	0.92	0.86–0.98	1,033	0.88	0.83–0.94
Brain and CNS	22	31	0.72	0.42–1.02	32	0.69	0.40–0.98
Breast	2	2	1.01	0.12–3.65	2	0.97	0.12–3.52
Connective soft tissue	13	12	1.08	0.57–1.84	13	1.04	0.55–1.78
Eye	8	5	1.57	0.70–3.10	5	1.52	0.67–2.99
Gastrointestinal	145	162	0.89	0.75–1.04	168	0.86	0.72–1.00
Colorectal	116	131	0.89	0.73–1.05	136	0.86	0.70–1.01
Colon	72	73	0.99	0.76–1.22	76	0.95	0.73–1.17
Rectum	43	55	0.78	0.55–1.02	57	0.75	0.53–0.98
Stomach	25	27	0.91	0.56–1.27	28	0.88	0.54–1.23
Genitourinary	189	173	1.09	0.94–1.25	180	1.05	0.90–1.20
Bladder	39	33	1.20	0.82–1.57	34	1.16	0.79–1.52
Kidney	41	37	1.12	0.78–1.46	38	1.08	0.75–1.41
Prostate	79	68	1.17	0.91–1.43	70	1.13	0.88–1.37
Testis	27	30	0.90	0.56–1.23	31	0.86	0.54–1.19
Hodgkin's disease	18	10	1.72	1.02–2.72	11	1.66	0.99–2.63
Leukaemia	34	31	1.09	0.72–1.46	32	1.05	0.70–1.41
Lymphoid	14	14	1.01	0.55–1.69	14	0.97	0.53–1.63
LL_acute	1	3	0.37	0.01–2.05	3	0.35	0.01–1.98
LL_chronic	11	8	1.30	0.65–2.32	9	1.25	0.62–2.23
Myeloid leukaemia	18	16	1.12	0.66–1.77	17	1.08	0.64–1.71
ML_acute	13	8	1.57	0.84–2.69	9	1.51	0.81–2.59
ML_chronic	4	6	0.67	0.18–1.72	6	0.65	0.18–1.66
Liver	1	9	0.11	0.00–0.62	9	0.11	0.00–0.60
Lung	43	80	0.54	0.38–0.70	83	0.52	0.36–0.68
Adenocarcinoma	13	25	0.52	0.28–0.89	26	0.50	0.27–0.85
Squamous	5	17	0.30	0.10–0.70	17	0.29	0.09–0.68
Small-cell	9	12	0.72	0.33–1.37	13	0.70	0.32–1.32
Large-cell	9	15	0.60	0.28–1.14	16	0.58	0.27–1.10
Other	7	11	0.66	0.26–1.35	11	0.63	0.25–1.30
Melanoma	231	207	1.12	0.97–1.26	214	1.08	0.94–1.22
Mesothelioma	4	8	0.53	0.14–1.35	8	0.51	0.14–1.30
Multiple myeloma	11	12	0.95	0.47–1.70	12	0.92	0.46–1.64
NHL	39	61	0.63	0.44–0.83	64	0.61	0.42–0.80
Oesophagus	6	13	0.48	0.17–1.04	13	0.46	0.17–1.00
Oropharynx and larynx	44	61	0.73	0.51–0.94	63	0.70	0.49–0.91
Head and neck	28	47	0.60	0.38–0.82	48	0.58	0.36–0.79
Larynx	16	14	1.15	0.66–1.86	14	1.11	0.63–1.79
Pancreas	9	17	0.54	0.25–1.02	17	0.52	0.24–0.98
Thyroid	9	11	0.80	0.36–1.51	12	0.77	0.35–1.46
Unknown primary	23	30	0.78	0.46–1.10	31	0.75	0.44–1.06

Table C.7: National Servicemen: Observed and expected numbers of cancer deaths, and standardised mortality ratios (SMR)

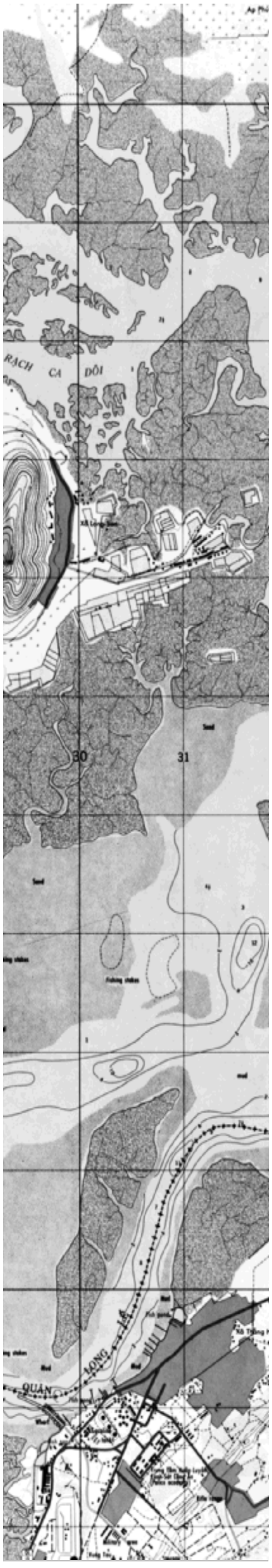
		Scenario 1 (excluding veterans whose status is unknown)			Scenario 2 (including veterans whose status is unknown)			
Cause of death	**Obs**	**Expected**	**SMR**	**95% CI**	**Expected**	**SMR**	**95% CI**	**Period**
All neoplasms	617	737	0.84	0.77–0.90	759	0.81	0.75–0.88	1966-2001
Brain and CNS	48	58	0.82	0.58–1.05	60	0.79	0.57–1.02	1966-2001
Breast	0	1	0.00	0.00–6.53	1	0.00	0.00–6.34	1966-2001
Connective soft tissue	11	10	1.15	0.57–2.04	10	1.12	0.55–1.99	1968-2001
Eye	2	1	1.87	0.22–6.70	1	1.82	0.22–6.50	1966-2001
Gastrointestinal	96	123	0.78	0.63–0.94	126	0.76	0.61–0.91	1968-2001
Colorectal	76	91	0.83	0.65–1.02	94	0.81	0.63–0.99	1966-2001
Colon	59	63	0.93	0.69–1.16	65	0.90	0.67–1.13	1966-2001
Rectum	17	27	0.64	0.37–1.01	28	0.62	0.36–0.98	1966-2001
Stomach	19	29	0.65	0.39–1.01	30	0.64	0.38–0.98	1966-2001
Genitourinary	31	54	0.58	0.38–0.79	55	0.57	0.37–0.77	1968-2001
Bladder	5	8	0.67	0.22–1.55	8	0.65	0.21–1.51	1966-2001
Kidney	11	22	0.51	0.25–0.89	23	0.49	0.24–0.87	1966-2001
Prostate	5	12	0.44	0.14–1.01	12	0.43	0.14–0.98	1966-2001
Testis	10	12	0.84	0.40–1.53	12	0.82	0.39–1.49	1966-2001
Hodgkin's disease	7	9	0.76	0.30–1.55	10	0.74	0.29–1.51	1966-2001
Leukaemia	34	40	0.87	0.58–1.15	41	0.84	0.56–1.12	1966-2001
Lymphoid leukaemia	8	10	0.82	0.36–1.60	10	0.80	0.35–1.55	1968-2001
Myeloid leukaemia	23	28	0.84	0.50–1.18	28	0.82	0.49–1.15	1968-2001
Liver and gallbladder	6	21	0.29	0.10–0.62	22	0.28	0.10–0.60	1966-2001
Lung	116	131	0.89	0.73–1.05	135	0.86	0.70–1.02	1966-2001
Melanoma	47	58	0.81	0.57–1.04	59	0.78	0.56–1.01	1966-2001
Mesothelioma	7	6	1.10	0.44–2.24	7	1.06	0.42–2.17	1997-2001
Multiple myeloma	12	11	1.13	0.58–1.96	11	1.10	0.56–1.90	1968-2001
Nasal	1	2	0.64	0.02–3.54	2	0.62	0.02–3.44	1964-2001
NHL	40	46	0.87	0.60–1.14	48	0.85	0.59–1.11	1966-2001
Oesophagus	20	24	0.83	0.47–1.20	25	0.81	0.46–1.16	1966-2001
Oral cavity, pharynx and larynx	35	38	0.94	0.63–1.25	39	0.91	0.61–1.22	1968-2001
Head and neck	27	29	0.94	0.59–1.29	30	0.91	0.57–1.25	1968-2001
Larynx	8	8	0.99	0.43–1.93	8	0.96	0.42–1.87	1966-2001
Pancreas	27	30	0.91	0.57–1.25	31	0.88	0.55–1.21	1966-2001
Thyroid	2	2	1.07	0.13–3.81	2	1.04	0.12–3.70	1966-2001
Unknown primary	38	37	1.03	0.70–1.36	38	1.00	0.69–1.32	1968-2001

Table C.8: National Servicemen, veterans: Observed and expected numbers of cancer deaths, and standardised mortality ratios (SMR)

		Scenario 1 (excluding veterans whose status is unknown)			Scenario 2 (including veterans whose status is unknown)			
Cause of death	**Obs**	**Expected**	**SMR**	**95% CI**	**Expected**	**SMR**	**95% CI**	**Period**
All neoplasms	296	326	0.91	0.80–1.01	332	0.89	0.79–0.99	1966-2001
Brain and CNS	28	26	1.07	0.67–1.47	26	1.05	0.66–1.44	1966-2001
Breast	0	0	0.00	0.00–14.98	0	0.00	0.00–14.70	1966-2001
Connective soft tissue	3	4	0.72	0.14–2.05	4	0.70	0.14–2.01	1968-2001
Eye	1	0	2.13	0.05–11.64	0	2.09	0.05–11.43	1966-2001
Gastrointestinal	38	54	0.70	0.47–0.92	55	0.68	0.47–0.90	1968-2001
Colorectal	30	40	0.73	0.47–1.00	41	0.72	0.46–0.98	1966-2001
Colon	19	28	0.69	0.41–1.06	28	0.68	0.40–1.04	1966-2001
Rectum	10	12	0.85	0.40–1.54	12	0.84	0.39–1.51	1966-2001
Stomach	7	13	0.55	0.22–1.11	13	0.54	0.21–1.09	1966-2001
Genitourinary	9	24	0.39	0.17–0.72	24	0.38	0.17–0.71	1968-2001
Bladder	1	3	0.31	0.01–1.68	3	0.30	0.01–1.65	1966-2001
Kidney	4	10	0.42	0.11–1.05	10	0.41	0.11–1.03	1966-2001
Prostate	0	5	0.00	0.00–0.73	5	0.00	0.00–0.71	1966-2001
Testis	4	5	0.77	0.20–1.92	5	0.75	0.20–1.89	1966-2001
Hodgkin's disease	4	4	0.99	0.26–2.48	4	0.97	0.26–2.44	1966-2001
Leukaemia	11	18	0.64	0.31–1.12	18	0.63	0.31–1.10	1966-2001
Lymphoid leukaemia	2	4	0.47	0.06–1.66	4	0.46	0.05–1.63	1968-2001
Myeloid leukaemia	8	12	0.67	0.29–1.28	13	0.65	0.28–1.26	1968-2001
Liver and gallbladder	4	9	0.44	0.12–1.10	10	0.43	0.11–1.08	1966-2001
Lung	68	58	1.18	0.90–1.46	59	1.16	0.88–1.43	1966-2001
Melanoma	14	26	0.56	0.30–0.92	26	0.55	0.29–0.90	1966-2001
Mesothelioma	3	3	1.07	0.22–3.08	3	1.05	0.21–3.01	1997-2001
Multiple myeloma	5	5	1.08	0.34–2.46	5	1.06	0.34–2.41	1968-2001
Nasal	0	1	0.00	0.00–5.28	1	0.00	0.00–5.18	1964-2001
NHL	21	21	1.04	0.60–1.48	21	1.02	0.59–1.46	1966-2001
Oesophagus	10	11	0.95	0.45–1.71	11	0.93	0.44–1.68	1966-2001
Oral cavity, pharynx and larynx	18	17	1.11	0.64–1.71	17	1.08	0.63–1.68	1968-2001
Head and neck	16	13	1.27	0.71–2.02	13	1.25	0.70–1.99	1968-2001
Larynx	2	4	0.56	0.07–1.99	4	0.55	0.07–1.96	1966-2001
Pancreas	19	13	1.46	0.86–2.24	14	1.44	0.85–2.20	1966-2001
Thyroid	1	1	1.23	0.03–6.68	1	1.20	0.03–6.56	1966-2001
Unknown primary	20	16	1.24	0.70–1.78	17	1.22	0.69–1.75	1968-2001

Table C.9: National Servicemen, non-veterans: Observed and expected numbers of cancer deaths, and standardised mortality ratios (SMR)

		Scenario 1 (excluding veterans whose status is unknown)			Scenario 2 (including veterans whose status is unknown)			
Cause of death	**Obs**	**Expected**	**SMR**	**95% CI**	**Expected**	**SMR**	**95% CI**	**Period**
All neoplasms	320	411	0.78	0.69–0.86	426	0.75	0.67–0.83	1966-2001
Brain and CNS	20	32	0.62	0.35–0.89	34	0.59	0.33–0.86	1966-2001
Breast	0	0	0.00	0.00–11.57	0	0.00	0.00–11.16	1966-2001
Connective soft tissue	8	5	1.49	0.66–2.94	6	1.44	0.64–2.84	1968-2001
Eye	1	1	1.67	0.04–9.29	1	1.61	0.04–8.95	1966-2001
Gastrointestinal	58	68	0.85	0.63–1.07	71	0.82	0.61–1.03	1968-2001
Colorectal	46	51	0.91	0.65–1.17	53	0.87	0.62–1.13	1966-2001
Colon	39	35	1.11	0.76–1.45	37	1.07	0.73–1.40	1966-2001
Rectum	7	15	0.47	0.19–0.96	16	0.45	0.18–0.92	1966-2001
Stomach	12	16	0.74	0.38–1.28	17	0.71	0.37–1.24	1966-2001
Genitourinary	22	30	0.74	0.43–1.04	31	0.71	0.41–1.00	1968-2001
Bladder	4	4	0.95	0.26–2.44	4	0.92	0.25–2.35	1966-2001
Kidney	7	12	0.57	0.23–1.18	13	0.55	0.22–1.13	1966-2001
Prostate	5	6	0.78	0.25–1.81	7	0.75	0.24–1.74	1966-2001
Testis	6	7	0.90	0.33–1.95	7	0.87	0.32–1.88	1966-2001
Hodgkin's disease	3	5	0.58	0.12–1.69	5	0.56	0.12–1.64	1966-2001
Leukaemia	23	22	1.04	0.62–1.47	23	1.01	0.59–1.42	1966-2001
Lymphoid leukaemia	6	6	1.09	0.40–2.37	6	1.05	0.39–2.29	1968-2001
Myeloid leukaemia	15	15	0.98	0.55–1.61	16	0.94	0.53–1.55	1968-2001
Liver and gallbladder	2	12	0.17	0.02–0.61	12	0.16	0.02–0.59	1966-2001
Lung	48	73	0.66	0.47–0.84	76	0.63	0.45–0.81	1966-2001
Melanoma	32	32	0.99	0.65–1.34	33	0.96	0.63–1.29	1966-2001
Mesothelioma	4	4	1.11	0.30–2.85	4	1.07	0.29–2.74	1997-2001
Multiple myeloma	7	6	1.18	0.47–2.42	6	1.13	0.45–2.33	1968-2001
Nasal	1	1	1.14	0.03–6.37	1	1.10	0.03–6.14	1964-2001
NHL	19	26	0.74	0.44–1.15	27	0.71	0.43–1.11	1966-2001
Oesophagus	10	14	0.74	0.36–1.36	14	0.71	0.34–1.31	1966-2001
Oral cavity, pharynx and larynx	17	21	0.81	0.47–1.30	22	0.78	0.46–1.25	1968-2001
Head and neck	11	16	0.68	0.34–1.21	17	0.65	0.33–1.17	1968-2001
Larynx	6	5	1.32	0.48–2.87	5	1.27	0.47–2.77	1966-2001
Pancreas	8	17	0.48	0.21–0.94	17	0.46	0.20–0.91	1966-2001
Thyroid	1	1	0.94	0.02–5.24	1	0.91	0.02–5.06	1966-2001
Unknown primary	18	21	0.87	0.51–1.37	22	0.84	0.49–1.32	1968-2001



D

Consultative Forum

Appendix D Consultative Forum

D.1. Chair

Major General Paul Stevens AO (Rtd)
Repatriation Commissioner to 24 August 2003

Rear Admiral Simon Harrington AM (Rtd)
Repatriation Commissioner from 25 August 2003

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Vietnam Veterans Association of Australia

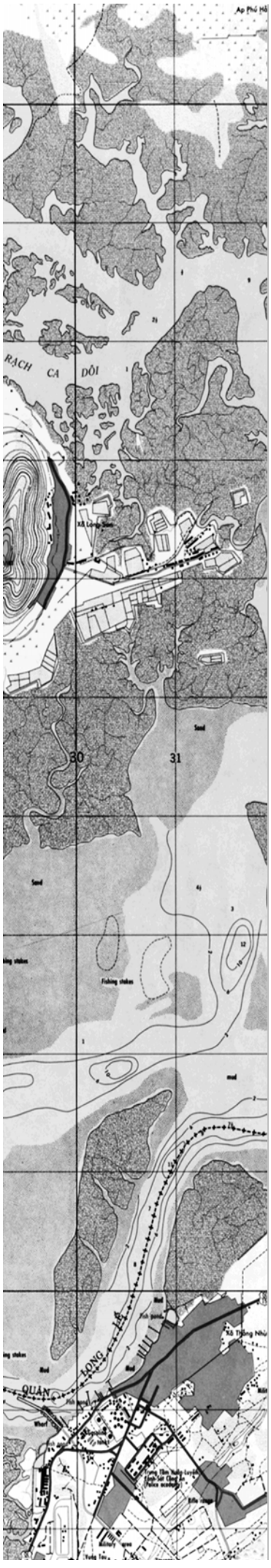
Mr Tim McCombe OAM
Vietnam Veterans' Federation of Australia

Mr John King
Returned & Services League of Australia Limited

Commodore Michael Dowsett AM (Rtd)
Naval Association of Australia

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



Scientific Advisory Committee

Appendix E Scientific Advisory Committee

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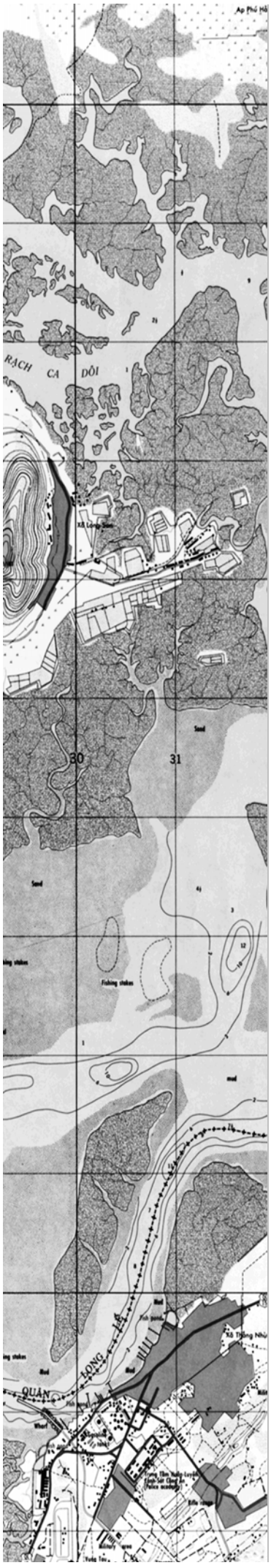
CSIRO Mathematical and Information Sciences



Project Team

Appendix F Project Team

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