Cancer incidence study 2003

Australian veterans of the Korean War

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REPATRIATION COMMISSION

16 August 2003

The Hon Danna Vale MP
Minister Assisting Minister of Defence and
Minister for Veterans' Affairs
Parliament House
CANBERRA ACT 2600

Dear Minister

I have pleasure in submitting the final report of the *Cancer Incidence Study of Australian Veterans of the Korean War* conducted by a team from the Australian Institute of Health & Welfare, headed by Dr Paul Jelfs. This study has investigated the incidence rates of cancer among Australian male veterans of the Korean War between 1982 and 1999 and compared these with the incidence rates over the same period for male members of the general Australian population of the same age.

Your predecessor had previously approved the conduct of a *Mortality Study of Australian Veterans of the Korean War*. The results of that study will be published separately and should be available shortly.

I would like to take this opportunity to thank the members of the Korean War Veterans Cancer Incidence Study Consultative Committee for their assistance and cooperation during the conduct of the study:

- Commander Ken Barnett – representing the Australian Veterans and Defence Services Council;
- Rear Admiral Ian Crawford AO AM(Mil) – representing the Regular Defence Force Welfare Association;
- Wing Commander Dick Cresswell DFC – representing the RAAF Association;
- Mr Syd Gellatly – representing the Korea and South East Asia Forces Association of Australia;
- Mr David Gibson PSM – representing the Department of Defence;
- Mr Norm Goldspink MBE – representing the Returned & Services League of Australia Limited;
- Dr James Henderson – representing the Korea War Veterans Association, NSW Inc;

- Mr Bill Hindson MC MG – representing the Australian Federation of Totally and Permanently Incapacitated Ex-Servicemen and Women;
- Major General Jim Hughes AO DSO MC – representing the RAR Association;
- Mr George Lang – representing the Association of Queensland Korean Veterans Inc;
- Mr John Manley OAM – representing the Naval Association of Australia;
- Colonel Alan McDonald – representing the Korean Veterans Association of Australia Inc; and
- Mr Ian Street – representing the Korean Veterans Tasmania.

The report's preparation was supervised by the Study Scientific Advisory Committee, chaired by Professor Priscilla Kincaid-Smith AC CBE, ably assisted by Professor Scott Henderson AO, Professor John McNeil, Professor Michael Moore and Professor John Zalcberg.

I would also like to thank Dr Keith Horsley, the Director of Research Studies and the other departmental staff who worked on the study.

Yours sincerely

Paul Stevens
COMMISSIONER

Professor Priscilla Kincaid-Smith

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14 August 2003

Major General Paul Stevens AO
Repatriation Commission
Lovett Tower
13 Keltie Street
WODEN ACT 2606

Dear Major General Stevens

I have great pleasure in providing you with a copy of the Report of the *Cancer Incidence Study of Australian Veterans of the Korean War,* which has been completed by the Australian Institute of Health & Welfare. The Scientific Advisory Committee has endorsed this study, undertaken by a team led by Dr Paul Jelfs.

Kind regards.

Yours sincerely

Priscilla Kincaid-Smith, AC CBE
Chair
Scientific Advisory Committee
Korean War Veterans' Health Studies.

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Acknowledgments

The study was commissioned and funded by the Australian Government. It was conducted at the Australian Institute of Health and Welfare (AIHW) under the *Australian Institute of Health and Welfare Act 1987*. The study was planned under the supervision of the Study Consultative Committee, and the technical guidance of the Study Scientific Advisory Committee. Members of each of these committees and the project team are listed in Appendixes B, C and E.

The authors of this report are Dr Indrani Pieris-Caldwell, Mr Phil Trickett and Dr Paul Jelfs. This report was peer reviewed by the Study Scientific Advisory Committee using its epidemiological expertise to examine the methods and findings of this study, clinical expertise in advising on medical aspects and a veteran representative to advise on conditions in Korea affecting health risks.

Men of B Company, 2 RAR, moving down off the Kansas Line to the battalion area after a week spent constructing defensive positions, 10 January 1954. AWM 157821

A pilot climbs into the cockpit of his Mustang at snow-covered Hambung airfield, North Korea, November 1950. AWM PO675/127/068

Executive summary

- The aim of this study was to examine the incidence of cancer experienced by the 17,381 Australian male veterans of the Korean War compared with that experienced in the Australian community for the period 1982–1999. These cancer patterns were examined for all Korean War veterans and for each of the Services—Navy, Army and RAAF.
- Work was commissioned by the Department of Veterans' Affairs (DVA) and was undertaken by AIHW under the supervision of the Study Consultative Committee and a Scientific Advisory Committee. The DVA and AIHW Ethics Committees provided approval for the work.
- The outcome of the study showed that Korean veterans experienced a significantly greater overall cancer risk than the Australian community, with an excess of between 13% and 23%, and varying significantly in the pattern across Services.
- At the commencement of the study period (1982), there were 15,041 veterans identified as being alive and eligible for the study. An additional 884 veterans (5%) could not be found after extensive searches of data systems and are referred to as 'veterans whose status is unknown'.
- There were 3,543 cancers identified in the veteran population in the period 1982–1999 using the DVA Korean nominal roll and the AIHW National Cancer Statistics Clearing House. The most common cancers found among the veteran population were cancer of the prostate (21% of the total cancers), lung cancer (19%), colon (8%), melanoma (7%), rectum (6%) and head & neck cancers (5%).
- To ascertain whether veterans experienced cancer at a similar rate to the Australian community, a series of steps were required to calculate the population 'at risk' for each year of the study (i.e. remove deaths). Once this was established the Australian community rate was applied to the 'at risk' population to determine how many cancers would be expected amongst the veterans.
- Deaths of veterans were identified both here in Australia using the AIHW's National Death Index and the state and territory Registrars of Births, Deaths and Marriages databases, and overseas using the New Zealand Registrar of Births, Deaths and Marriages database.
- The 5% of veterans whose status is unknown posed a problem for the study in that they needed to be taken account of, as including them or excluding from the population 'at risk' significantly influenced how many cancers might be expected amongst veterans.
- Two 'at risk' population Scenarios were derived to manage this issue. Scenario 1 excludes veterans whose status was unknown from the at-risk population and Scenario 2 includes this group in the at-risk population. The report presents findings under both Scenarios.
- The study compared cancers in veterans with those expected based on Australian community rates under the two Scenarios, by producing standardised cancer incidence ratios. Where the ratio exceeds one, the actual cases of cancer among veterans are higher than the expected number, and vice versa. However, these results also need to be considered along with the confidence intervals around each ratio, which help indicate statistical significance. The findings reported below only highlight those results that have been found to be statistically significant.

Results

- The incidence of all cancers among Korean War veterans was 23% higher (Scenario 1) and 13% higher (Scenario 2) than expected compared with the Australian community rate.
- Compared to the expected number of cases, veterans experienced higher cancer incidence ratios under Scenario 1 and 2 for head & neck cancers (90% and 76% respectively), larynx cancer (72% and 60%), oesophagus cancer (54% and 42%) and lung cancer (42% and 31%). Smoking is a major risk-factor associated with each of these cancers.
- A further analysis of smoking-related cancers was undertaken to determine if smoking alone could explain all of the elevation in the incidence among veterans. The results indicate that even if 100% of veterans were smokers, the excess number of head & neck cancers would not have been explained by smoking alone, suggesting that there may be other factors influencing the elevation.
- Similarly, smoking prevalence rates would have had to reach 90% and 82% (under Scenario 1 and 2) to explain the cancer of the larynx ratios, 86% and 77% for cancer of the oesophagus, and 64% and 59% for cancer of the lung.
- Other cancers with significantly higher incidence among veterans, but only for Scenario 1, were melanoma and cancers of the prostate, colon and rectum.

Service type

- Cancer incidence among the Korean War veterans was analysed further by type of Service (Navy, Army and RAAF).
- The results showed that the total incidence of cancer among those who served in the Navy was 25% higher (Scenario 1) and 17% higher in Scenario 2. Prostate cancer (30% and 20% higher), head & neck cancer (93% and 81%), and lung cancer (25% and 17%) all showed significantly higher incidence among Navy veterans.
- Army veterans experienced 25% and 13% higher overall cancer incidence (Scenario 1 and 2). Lung cancer (59% and 44% higher), head & neck cancers (91% and 74%), cancer of the larynx (105% and 87%), and liver cancer (78% and 61%) all showed significantly higher incidence among Army veterans.
- Under both Scenarios, veterans who served in the RAAF showed no difference in the incidence of total cancer, but showed statistically significantly higher rates of melanoma (68% and 64%) under both Scenarios.

Duration of service by Service type

An analysis examining the relationship between cancer incidence and duration of service (short, medium and long duration) in Korea was conducted for the Army. There were insufficient numbers of cancer in the Navy and RAAF to provide a statistically reliable comparison.

- The key results from the analysis were that the number of all cancers experienced by Army veterans who served in the Korean War for a short, medium and long duration were 21%, 28% and 26% higher than expected in Scenario 1. Scenario 2 showed 10%, 16% and 13% higher numbers than expected respectively.
- The excess incidence of head & neck cancers, lung and larynx cancers among Army veterans compared with the Australian community increased consistently with duration of service under both population Scenarios, as the duration of their service in Korea increased from short to long duration category.

Mortality

- Of Korean War veterans who had developed cancer between 1982 and 1999, over 58% of veterans had died by 1999. Of these veteran deaths, the underlying cause of death in 71% of cases was the same cancer suffered by the veterans. Particularly notable were lung (89% of those dying with the same cancer), pancreas (89%), oesophagus (80%), liver (85%), brain (93%) and leukaemia (72%) cancers, which contributed greatly to the death toll of the Korean War veterans.
- A more comprehensive analysis of mortality patterns has been undertaken in another volume of the Korean War veterans' studies, examining the comparisons of mortality with the rest of the Australian community.

Two Bofors gunners enjoy a quiet moment on HMAS *Murchison* at Fork Anchorage, Han River estuary, 1951. AWM 044747

The Kapyong valley—looking across at the location of the B Company, 3 RAR positions of 25 April 1951. AWM 147836

Fairey Firefly (left) and Hawker Sea Fury (right) aircraft parked on the deck of HMAS *Sydney* in January 1952. The snow and ice made this a non-flying day. AWM PO1838.014

1 Introduction and background

In the period 1997 to 2002, the Department of Veterans' Affairs (DVA) has been authorised to conduct three studies relating to the health of the Australian veterans of the Korean War 1950–1956:

- a Mortality Study;
- a Cancer Incidence Study; and
- a Health Survey.

Each of these studies will be reported separately.

This study is the second of the group of three, the Cancer Incidence Study, and was announced by the then Minister for Veterans' Affairs on 10 May 2001.

The study was prompted by concerns from the Korean War veteran community that their cancer incidence was higher than in the Australian male population.

The Australian Institute of Health and Welfare (AIHW) was commissioned by DVA to conduct the study by linking data on male veterans with the National Cancer Statistics Clearing House (NCSCH) database.

1.1 Overview of the Korean War and Australia's involvement

The Korean War commenced on 25 June 1950, when the North Korean People's Army launched an all-out offensive on the Republic of Korea. The conflict continued until 27 July 1953, when a cease-fire took effect. Significant numbers of United Nations forces, including Australian Defence Force (ADF) units, continued to serve in Korea after 1953 to enforce the cease-fire. Indeed, to date a formal end of the war is yet to be declared. From late June 1950 to April 1956, when the last ADF units were withdrawn, 17,872 Australians served in Korea. Of these, 339 were killed during 1950–1953, the active phase of the war, 1,216 wounded and 29 taken prisoner of war. (Consolidated Library of Information and Knowledge 2001; O'Neill 1985). A further 10 persons died in Korea between the cease-fire in July 1953 and April 1956.

The war was fought over rugged mountainous terrain under climatic conditions that varied from extreme heat during summer to near-arctic temperatures during the winter. These temperatures, particularly in winter, presented a severe challenge to crews of ships built for temperate conditions and for troops and aircraft ground crews required to carry out their duties despite the conditions. The first winter proved to be the most demanding because clothing on issue had been designed for Australian winter conditions and was entirely inadequate for Korea. More appropriate clothing was obtained from United Kingdom and United States sources during subsequent winters (Consolidated Library of Information and Knowledge 2001).

In its conduct, the war can be divided into two phases. The first consisted of an active mobile phase with offensives and counter-offensives taking place over long distances in line with changing strategic circumstances. The second phase, from around the middle of 1951 until the cease-fire, was characterised by the maintenance of relatively static positions along a front that eventually became the cease-fire line. Actions during this period were largely

aimed at gaining local tactical advantage and retaining the initiative over the enemy (O'Neill 1985).

The first ADF units to participate in the war were the Royal Australian Navy (RAN) ships *Bataan* and *Shoalhaven* and the Royal Australian Air Force (RAAF) 77 Fighter Squadron. These were committed in late June 1950. The first Australian Army unit, the Third Battalion, Royal Australian Regiment (3RAR), arrived in Korea on 28 September 1950 (O'Neill 1985).

1.1.1 Royal Australian Navy (RAN)

RAN ships were employed in patrolling, engaging shore batteries, gun-fire support, carrier screening and many other demanding tasks. Major operations included participation in the covering force for the amphibious assault on Inchon, on the coast west of Seoul on 15 September 1950 and a subsequent assault on Wonsan on the north-east coast of North Korea on 7 November 1950. Following the entry of China into the war, RAN ships assisted in the evacuation of Chinnampo, the port for the North Korean capital of Pyongyang.

Navy involvement also included two deployments of its first aircraft carrier, HMAS *Sydney*. The first was from August 1951 to February 1952, during which its aircraft flew ground attack missions against enemy forces. Its second deployment took place during the post cease-fire enforcement period.

One of the most notable individual operations involved HMAS *Murchison*, which from July to November 1951 conducted a number of bombardment duties in the Han River estuary. Hazards to the ship included high tide ranges, shifting mud flats, the lack of navigation marks and the close proximity of enemy forces. HMAS *Murchison* accumulated more time in the estuary than any other allied ship and engaged enemy forces at close range on many occasions.

In addition to temperature extremes, climatic threats included storms and typhoons. Other dangers included high tidal ranges, fast local currents, shifting mud flats and a rapidly changing sea-bed. At various times, floating sea-mines were also a serious threat.

1.1.2 Australian Army

The Australian Army participation commenced with the arrival of 3RAR in Korea in 1950. This battalion remained in Korea for the duration of the war, but from 1952 to 1953 was joined on a rotation basis by either 1RAR or 2RAR. In addition to the infantry, a number of individuals from other fighting or service corps served in Korea, particularly following the formation of the 1st Commonwealth Division in July 1951.

In the early phase, 3RAR participated in a number of major battles both while advancing towards the Chinese border and subsequently, following the entry of China into the war in November 1950, during various retreats and advances as military fortunes changed. Towards the end of this period, on 24 April 1951 during the battle of Kapyong, 3RAR held off an attack by a Chinese division. This action resulted in the loss of 32 men killed, 59 wounded and 3 captured.

The second major Australian infantry battle of the war also involved 3RAR. This resulted in the capture of Hill 317 and became known as the Battle of Maryang San. The action lasted from 2 to 8 October 1951 and led to the destruction of at least two Chinese battalions. 3RAR lost 20 men killed and 89 wounded.

During the last years of the war, Australian battalions built and occupied strongly fortified underground defensive positions on the front line. They mounted nightly fighting patrols to

seize the initiative and dominate no man's land, conducted raids against entrenched Chinese positions and fought a number of offensive and defensive battles. One of the more significant of the latter was the defensive battle on 'the Hook' by 2RAR in July 1953.

1.1.3 Royal Australian Air Force

On the outbreak of war, the RAAF's 77 Fighter Squadron was in Japan preparing to return to Australia. It was rapidly re-mobilised and flew its first combat mission on 2 July 1950. During this period, up until April 1951, the Squadron flew P51D Mustang piston-engine fighters in ground attack and air support roles.

The entry of China into the war led to the appearance of Mig15 jet fighters, which directly threatened UN Command air superiority. With United States Air Force squadrons having priority on delivery of the latest jet fighters, the decision was taken to purchase British Meteor jets for 77 Squadron despite their known inferiority to the Mig15.

The Squadron's first jet operational mission was flown on 29 July 1951. Combat experience quickly confirmed this inferiority, particularly at high altitude. However, the aircraft proved its worth in the ground attack role. By May 1952 the Squadron was employed escorting fighter-bombers at lower altitudes where Mig15 superiority was much less marked and by the end of the war, five Migs had been destroyed in air-to-air combat.

The RAAF also provided transport support using C47 Dakota aircraft. The transport flight was expanded several times as demand increased and eventually became 36 Transport Squadron. In addition to general transport duties, unit aircraft carrying RAAF nurses flew some 12,000 sick and wounded from the war zone in medical evacuation flights.

Technical support for RAAF aircraft was provided by 91 (Composite) Wing located at Iwakuni in Japan, but with maintenance elements located in the 77 Squadron area in Korea.

1.2. Health and environmental threats

In the absence of documentation on environmental health risks during the period of the Korean War, the following assessment has been based on that currently applicable to North Korea, as documented in *Korean Infectious Disease Risk Assessment* (Department of Defence not dated).

Also of relevance is that Australian military operations from September to December 1950 largely took place in North Korea. This included the first experience by ADF personnel of a Korean winter. The period covered the advance by ground forces towards the Chinese border followed by retreat in the face of the first Chinese offensive, which pushed the allies to a line south of Seoul by January 1951. Subsequent offensives pushed the war zone back to the north towards and around the 38th parallel. By early 1952, positions held by both sides of the conflict were consolidated along a line around the 38th parallel. Following the cease-fire, this line stabilised into the post-war De-militarised Zone (DMZ) that marks the current border between the two countries.

Temperatures

In the region encompassing the North Korean capital, Pyongyang, summers (June through to September) have mean daily maximum temperatures of approximately 26°C and mean daily minimums of about 19°C. Daily extreme highs occasionally reach 37°C, while extreme lows occasionally drop to 0°C (Figure 1).

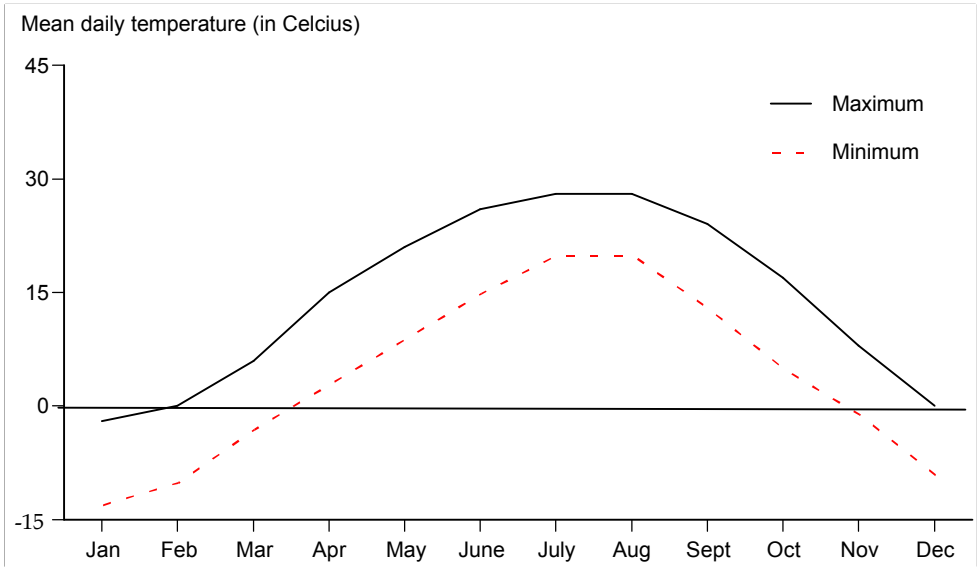

Figure 1: Mean daily temperature in Pyongyang

Winters in the same region of Korea last from November through to March. Mean daily minimum temperatures are approximately –4°C and mean daily maximum temperatures are about 2°C. Daily wind-chill temperatures commonly reach –31°C.

The temperature extremes between summer and winter presented a range of threats to ADF members. Some of these threats were unique to an individual Service.

Ships operated by the Royal Australian Navy during the period of the Korean War were steam powered and built for temperate conditions. They were not air-conditioned. This meant that crews endured high temperatures during the summer months or in tropical regions. Within each crew, those serving in areas such as engine and boiler rooms and galleys would have been exposed to extreme temperatures.

Conversely, during the winter months in Korean waters, a thin steel hull in direct contact with freezing sea water combined with the lack of insulation and minimal heating meant that crews had to endure freezing conditions below as well as on deck. Conditions were particularly severe for those in exposed positions, such as open bridges and gun positions. This group included watchkeepers and those manning weapon systems at action stations. These conditions were exacerbated in the first winter as, in common with the other two Services, crews had not been issued with adequate cold weather clothing.

In order to maintain what heat could be generated, ships were often closed up which meant that the air below decks became stale. Further, the presence of relatively large numbers of crew confined within a small, poorly ventilated space presented a significant risk of the spread of diseases by contact or aerosols. This danger would have been exacerbated by a practice recalled by several RAN veterans from the conflict. These veterans have advised that, in addition to closing up ship, other methods tried in an attempt to maintain a habitable temperature included venting steam directly into the ship from its boilers. This method provided only short-term relief and temperatures fell rapidly. The resultant high humidity and moisture in crew accommodation areas would have provided an environment very suitable for moulds and other potential disease sources.

Six members of 3 RAR make their way along a snow-covered terrace, Korea, February 1951. AWM PO1813.510

Men of C Company, 3 RAR, establish defensive positions near Pakchan prior to sending out foot patrols, Korea, November 1950. AWM 147029

The Army experience can be divided into two parts. During the first (active) phase troops were continually on the move both in advance and retreat. Tactical positions were held for short periods and trench digging was limited to the minimum required. One concern during this phase arose as the first winter set in, when it became quite apparent that clothing worn by Australian troops was entirely unsuited to winter conditions in northern Korea. Uniforms were essentially unchanged from those worn by troops in both World War I and II and provided no protection against severe cold. Following this experience, Australian soldiers began to acquire items of US military winter clothing that was better suited for the purpose. Apart from trying to maintain body temperature, significant problems arose due to frost-bite and injuries arising from flesh sticking to frozen weapons, vehicles and other metallic objects.

During the subsequent static phase, substantial defensive positions were dug along hill-tops and ridges. These comprised fighting bunkers, command posts and living quarters, all connected by communications trenches and incorporating substantial overhead cover for protection against artillery shell fire. Living quarters were underground sleeping bunkers, known as 'utchies' (not to be confused with the more recent 'hutchies', which are small tents). These bunkers slept either four or six men and were cramped and poorly ventilated.

During the summer monsoonal season, it was not possible to keep bunkers dry and if utchies were not well built, they could collapse. During such periods, soldiers on 'stand-to' could be up to their knees or waist in mud and water. The end result was that soldiers could not get dry for weeks at a time.

Troops slept during the day and were active during the night. Activities included both heavy manual labour in maintaining and developing defensive positions, and patrolling aimed at establishing the initiative over the enemy and denying its use of 'no man's land'. Patrols were dispatched at night under all weather conditions. During winter, standing and ambush patrols in particular required participants to remain motionless for long periods in conditions of extreme cold.

Freezing temperatures during winter also meant that fresh water for drinking, cooking or washing was in short supply. Drinking water was sometimes obtained by heating snow.

Temperature extremes similarly presented difficulties to the Royal Australian Air Force, both for aircrew kitted out and waiting to fly and to the ground crew that had to maintain the aircraft. During summer, aircrew had to contend with the heat on the ground, while kitted out to cope with the cold experienced at high altitudes. During winter, the additional clothing required both on the ground and in the air significantly restricted freedom of movement of limbs.

For ground crew, maintenance was required to be done at night at the end of each day's flight program to ensure aircraft were airworthy and armed ready for the next day's missions. As with the Army, extreme cold during winter months caused significant problems with frost-bite and flesh sticking to cold metal tools and aircraft components.

Rainfall in Pyongyang

Summer is the monsoon season and in the Pyongyang area, approximately two-thirds of the total annual rainfall of 1,000 mm occurs during July and August (Figure 2). Severe flooding occurs frequently and typhoons make occasional appearances.

For the RAN, the chief concern arising from weather, including precipitation, was from an operational point of view. This aspect was brought home emphatically for the crew of the aircraft carrier HMAS *Sydney* on the night of 14–15 October 1951 when it rode out a typhoon at sea, experiencing high seas and wind gusts peaking at 100 knots.

In the case of Army troops living in trenches and underground dugouts without adequate drainage, periods of high precipitation mean living with water underfoot, the threat of collapsing trench walls, constantly damp clothing and the threat of conditions such as trench feet. Damp conditions, including stagnant pools of water, also provide a breeding ground for diseases and disease vectors. This is discussed further below.

The RAAF, like the RAN, was chiefly concerned with the impact of weather on operational activities. Concerns included flights with inadequate radio navigation aids in instrument meteorological conditions over mountainous terrain. As with the Army, however, health threats on the ground would also include the threat from disease vectors breeding in standing water.

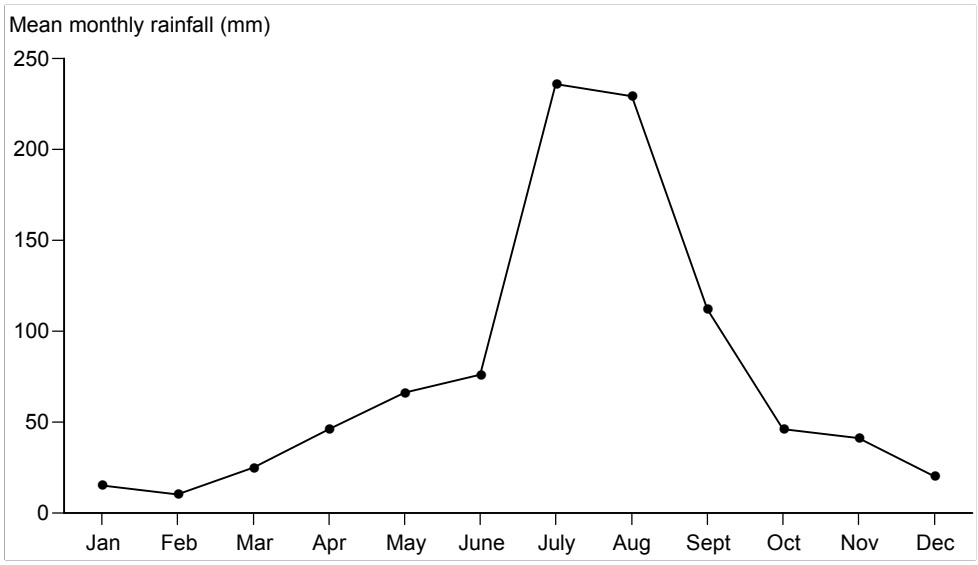

Figure 2: Mean monthly rainfall in Pyongyang

Other environmental threats to Australian service personnel in Korea

Korean War veterans have expressed concern about the high levels of exposure to chemicals, including DDT, during the Korean War. Anecdotal evidence suggests the level of exposure to both DDT and other insecticides was extreme, particularly among medical orderlies and others, often inadequately trained for the task, who were responsible for mixing and spraying them.

DDT and other insecticides were used extensively in unit areas where fogging machines were used to treat tent-lines and other general areas. Individual application was in the form of insecticide powders applied directly to the body or clothing. Army personnel most exposed included those located in front-line or support echelon units and in units stood down to rest areas behind the lines, with tent-based accommodation. In all areas, vigilant control of vectors of insect-borne diseases was required. RAAF personnel living and working in 77 Squadron unit areas would have faced very similar exposures.

Of the other environmental threats faced by all three Services, exposure to cigarette smoke was widespread. Cigarettes were freely available in large numbers and smoking was extensive among ADF members. Even non-smokers were exposed to high levels of cigarette

smoke, particularly in Army front-line areas, where soldiers lived in confined and poorly ventilated underground areas.

Other exposures raised by veterans included alcohol and morphine abuse. Access to alcohol was strictly controlled in combat areas, but it was readily available to personnel on leave in Japan. Morphine, on the other hand, was available in the combat zone to treat combat casualties as they occurred. Anecdotal evidence suggests some limited abuse or the potential for abuse, but it was not a widespread problem.

On the individual Service level, threats faced by RAN crews included both those common to all ships of the period and others that were more specific to ships operating in Korean waters. Chief among the general threats was exposure to asbestos, which was present aboard all Navy ships.

RAN ships of the period were steam-powered and asbestos was used extensively to lag boilers, engine rooms and steam pipes. Steam pipes ran throughout the ship, including through crew living and eating areas. Asbestos was also used as a fire retardant on all ships, but in particular aboard the aircraft carrier HMAS *Sydney*, where additional protection was required to reduce the risk of fire fuelled by aircraft fuel tanks, munitions and aviation fuel stores.

The risk of exposure to asbestos was elevated during maintenance periods when it would have been necessary to disturb or repair lagging or bulkheads treated with asbestos as a fire retardant. It would also have been elevated during times when ships were closed down during action stations or while trying to conserve heat in winter. During these periods, the flow of fresh air within the ship was reduced to a minimum, leading to a rise in the concentration of airborne asbestos dust particles.

A further potential threat to health was identified during the 1997 Vietnam Veterans Mortality Study (VVMS), arising from the method used to produce fresh water for use in ships' boilers and by their crews. Under a process used extensively up until the introduction of reverse osmosis in the late 1980s, fresh water was obtained by low-pressure vapour distillation of seawater. It has now been shown that this process has a potential to concentrate volatile contaminants, including herbicides or pesticides that may have been present in the seawater used as feed-stock. Ships operating within Korean coastal waters may have been exposed to organic wastes, pesticides and other contaminants washed out by rivers and other run-off. Most of Korea's major rivers drain into the relatively shallow waters off the western and southern coasts where RAN ships spent much of their time on patrol. Smaller ships and those on shore bombardment duties operated closer to shore where contamination levels could be expected to be higher.

Within the Army, all members during winter were exposed to high levels of hydrocarbon combustion products produced by heating devices known as 'choofers' and solid-fuel 'hexamine' heating blocks used for cooking. Both were utilised within the confined and poorly ventilated underground space of individual 'utchies'.

Choofers typically utilised a drip-feed system to add fuel to a fire contained within a metal drum. A common source of such fuel was petrol syphoned from jeeps. The degree of combustion would have been uncertain at best and resulted in the distribution of a mixture of soot and partially burnt combustion products throughout the living area. One by-product of this was a condition known as 'choofer neck', where the grime built up around necks and collars.

'Hexamine' tablets were hydrocarbon-based solid-fuel tablets used as a heating source for cooking individual meals. Food or water was heated directly and combustion products from the tablets would mix freely within the living area. At times of peak activity the combined

effect of choofer and hexamine fumes, together with cigarette smoke, would have made the atmosphere within an 'utchie' particularly polluted.

Other exposures of interest included exposure to petroleum fuel and lubricants, particularly by transport personnel and aircraft ground crews (both Fleet Air Arm and RAAF), and exposure to asbestos dust from brake pads among maintenance personnel.

1.3 Objectives of the study

The objectives of the study are:

- To identify cases of cancer (excluding non-melanocytic skin cancers) among Korean War veterans over the 1982 to 1999 period.
- To compare the number of cases of cancer among Korean War veterans with the number of expected cancers based on the cancer incidence of the Australian community.
- To report any differences in cancer incidence between Korean War veterans and the Australian community.
- To investigate any differences in cancer incidence between Navy, Army and RAAF Korean War veterans.
- To investigate any relationship between cancer incidence among Korean War veterans and duration of service in Korea.

1.4 Study organisation and administration

The study was commissioned and funded by Department of Veterans' Affairs. It was conducted by a project team at the Australian Institute of Health and Welfare under the *Australian Institute of Health and Welfare Act 1987*. The study was planned under the supervision of the Study Consultative Committee, gained ethics approval, and was given technical guidance by the Study Scientific Advisory Committee.

Department of Veterans' Affairs

The conduct of this study was a responsibility of DVA on behalf of the Repatriation Commission.

Study Consultative Committee

The Study Consultative Committee, with representatives from Korean War Ex-Service Organisations, DVA, the Department of Defence and AIHW, was established to provide advice on the conduct of the study. This committee provided a forum for discussion on issues relating to the study methodology and for feedback from veterans. The composition of the committee is shown in Appendix B.

Study Scientific Advisory Committee

The Study Scientific Advisory Committee consists predominantly of respected academics with expertise relevant to this study. It was established to review and advise on the methodology used in the study. The composition of this committee is shown in Appendix C.

Study protocol

A protocol for the study was produced and agreed by DVA, AIHW, the Study Consultative Committee and the Study Scientific Advisory Committee. The protocol is in Appendix D.

Project staff

The project staff for the study are listed in Appendix E.

Ethics Committee

The protocol document for this study was approved by the AIHW and DVA Ethics Committees. Additional approvals were also provided by state and territory cancer registry ethics and data review committees. These protocols were to ensure that the linkage of the veterans' names against the National Cancer Statistics Clearing House (NCSCH) and the state and territory cancer registries was appropriate.

1.5 Structure of this report

Chapter 2 explains the data sources used and the methodology of this study.

Chapter 3 presents the findings of the study which include:

- an investigation of the incidence of cancer for male veterans of the Korean War;
- a comparison of the incidence of cancer of Korean War veterans with that of the overall male population of Australia to identify significant risks for the veterans;
- an investigation of the contribution of smoking to smoking-related cancers among Korean War veterans;
- a comparison of cancer incidence of Korean War veterans by their Service type (Navy, Army or RAAF) to the expected cancer incidence based on the Australian community;
- an exploration of the impact of duration of service in Korea on cancer incidence of Navy and Army veterans; and
- a brief analysis of the likelihood of dying among Korean War veterans diagnosed with cancer.

Conclusions from the study are presented in Chapter 4.

Men of 3 RAR prepare to go out on patrol, 1953. Behind them is one of the many bunkers that were constructed during the period of trench warfare. AWM PO964/16/07

Two Gloster Meteor F.8 fighters of 77 Squadron RAAF streak low over a Korean village as they head north from Kimpo, South Korea, 1952. AWM JK0604

2 Data and methodology

This chapter describes the sources of data and the methods used to produce statistics comparing cancer incidence among male Korean War veterans with the incidence among the male Australian community. Female Korean War veterans were not included in the scope of this study because their numbers were too few to allow statistically reliable results to be obtained.

2.1 Data sources

The data sources used in this study are:

- **The Korean War Veterans' Nominal Roll maintained by DVA**

  The nominal roll provides a list of names and dates of birth of 17,814 male veterans (there are also 58 female veterans on the roll) who served in the Australian Defence Force (ADF) in Korea during the period 1950–1956. The roll also contains the Service type and all deaths of veterans notified to DVA. This roll forms the basis of the study population. Any individual who was a member of the ADF, or a civilian from an organisation accredited by the ADF, who physically entered the Korean Operational Area during the qualifying period between July 1950 and April 1956, was included in the nominal roll. There was no specific length of time required for a person to have been in Korea to be included on the nominal roll.

- **The National Cancer Statistics Clearing House (NCSCH) Database**

  The NCSCH database contains notifications of cancer (excluding non-melanocytic skin cancer) diagnosed in Australia for the period 1982–1999 and is located at AIHW. State and territory Cancer Registries contribute these data to the NCSCH, which currently contains information on 1.3 million cancers experienced by 1.2 million people. The database is updated annually.

- **The National Death Index (NDI)**

  The National Death Index is a database, housed at AIHW, containing records of all deaths occurring in Australia since 1980. The data are obtained from the Registrars of Births, Deaths and Marriages in each state and territory. The NDI currently contains information on approximately 2.7 million deaths.

2.2 Study methods

A comparison between the incidence of cancer in Korean War veterans and that of the male Australian community was carried out for a range of the most common cancers in the Australian population, as identified in the study protocol. Any cancer identified as having a substantial number of cases in the veteran population was also included in the analysis.

The processes involved in the analysis were:

- The Korean War veteran population was matched to the NCSCH to identify cancers diagnosed in veterans between 1982 and 1999. Some Korean War veterans would have experienced cancer prior to 1982, but no NCSCH records exist for this period to enable a comparison of veterans' cancer experience with that of the Australian community.

- The expected number of cancers of veterans in each year was calculated by applying the age and sex-specific cancer incidence rates of males in the Australian community to the veteran population alive at each year from 1982 to 1999. To obtain the number of veterans alive at 30 June each year from 1982 to 1999, deaths of veterans were identified by matching the veteran population to the NDI.
- The observed number of cancers among Korean War veterans was then compared to the expected number of cancers, and tested for any statistically significant differences.

2.2.1 The matching process—identifying the cancers and deaths in veterans

Before undertaking the data match between the DVA nominal roll, and the NDI and the NCSCH, Ethics Committee approvals were obtained from DVA and AIHW. In addition, for the matching between the nominal roll and the NCSCH, it was necessary to obtain Ethics Committee approvals from each of the state and territory Cancer Registries.

All data matching was undertaken by AIHW staff using the Integrity probabilistic matching software. Personal information such as full name and date of birth was used in matching the veterans' nominal roll to the NDI and the NCSCH. In addition, last known date of contact by DVA and, when available, date of death were used to determine exact matches of persons.

The matching strategies used were able to capture different variants of a name, and misspelled and transposed names and dates. The matching program could be set to pick up variation in dates of events (e.g. dates of birth or death). For example, a person aged 65 years in 2000 may be recorded in the NDI as being born in 1934 or 1935. The matching algorithm could be set to allow for such differences in dates.

The matching process against the NDI identified veteran deaths, so that the living veteran population could be calculated for each year from 1982 to 1999. This estimate of the living population is used in the calculation of the expected cases of cancer (see Section 2.2.2).

Matching against the NCSCH identified all cases of cancer between 1982 and 1999 apart from non-melanocytic skin cancers, which are not routinely reported to the cancer registries. Individual cases are only recorded once on the NCSCH. However, an individual may experience more than one type of cancer, and each of these is recorded on the NCSCH, and is included in this analysis.

2.2.2 Expected number of cancers in veterans

The expected number of cases of cancer by type of cancer was calculated for each year by applying the single year of age incidence rates of cancer for the Australian male community to the age-specific number of living Korean War veterans in each year.

The steps involved in these calculations were:

- calculate incidence rates for the Australian male population for each cancer being studied, by single year of age, for each year from 1982 to 1999;
- derive the population of living Korean War veterans (population at risk) by single year of age for each year from 1982 to 1999, from the nominal roll of Korean War veterans; and
- for each year 1982 to 1999, calculate the expected number of cases of the cancer being studied had veterans experienced the cancer incidence rates of the general Australian community. This was done by multiplying the age-specific incidence rates for the Australian population by the corresponding veteran population by age, of that year.

The calculation of the expected number of cases for head & neck cancer for 1999 is illustrated in Table 1. 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 colon cancer can be added to the observed and expected numbers for rectum cancer to obtain the observed and expected cases of colorectal cancer.

It should also be noted that the illustration in Table 1 is only for one year. Comparisons between observed and expected cases of cancer in this study are made for the 1982–99 period, by summing the annual expected and actual cases.

Table 1: Comparison of incidence of head & neck cancer between male Korean War veterans and the total Australian male population, 1999

Age	Living Korean War veteran population 1999	New cases of head & neck cancer per 100,000 population, Australia, 1999	Expected cases of head & neck cancer among Korean War veterans, 1999	Observed cases of head & neck cancer among Korean War veterans, 1999	Standardised incidence ratio
62[(a)]	14	35.8	0.0050	0	
63	71	44.4	0.0315	0	
64	326	37.7	0.1230	1	
65	625	39.6	0.2474	1	
66	927	51.4	0.4761	1	
67	896	45.4	0.4064	1	
68	1,102	48.5	0.5348	1	
69	1,138	44.4	0.5058	1	
70	1,002	56.3	0.5639	1	
71	1,053	64.6	0.6803	1	
72	745	47.5	0.3536	1	
73	581	62.9	0.3656	0	
74	428	61.0	0.2609	0	
75	312	57.0	0.1779	0	
76	255	34.9	0.0890	0	
77	172	60.3	0.1037	0	
78	167	47.7	0.0796	0	
79	126	61.3	0.0772	0	
80	78	44.5	0.0347	0	
81	71	56.3	0.0400	0	
82	60	57.0	0.0342	0	
83	41	39.9	0.0163	0	
84	32	61.3	0.0196	0	
85	19	77.3	0.0147	0	
86	20	78.1	0.0156	0	
87	14	9.6	0.0013	0	
88	7	60.1	0.0042	0	
89	4	74.9	0.0030	0	
90	10	39.4	0.0039	0	
91	4	78.0	0.0031	0	
92	4	69.6	0.0028	0	
93	2	0.0	0.0000	0	
94	0	65.4	0.0000	0	
95	6	0.0	0.0000	0	
Total	**10,312**		**5.3**	**9**	**1.7**

(a) Age 62 is the youngest age group comprising living Korean War veterans in 1999.

Veteran population at risk

To calculate the expected number of cases of cancer in the Korean War veteran population it was necessary to estimate the living Korean War veteran population, that is, the population at risk of developing cancer, by single year of age for each year from 1982 to 1999. To estimate these populations, it was first necessary to identify all deaths of Korean War veterans since war service. A number of processes were undertaken to identify deaths not already recorded on the nominal roll by DVA:

- The list of all names on the nominal roll was matched to the NDI to identify deaths of veterans since 1980. The NDI holds information on deaths of all persons who died in Australia from 1980 onwards.
- To identify pre-1980 deaths, the AIHW contacted the Australian state and territory Registrars of Births, Deaths and Marriages.
- AIHW also contacted the Registrar of Births, Deaths and Marriages in New Zealand to identify veterans who may have migrated to New Zealand and subsequently died.
- Trial matching against the web-based USA Social Security Death Index (SSDI) was conducted but was found unfeasible for large dataset matching.

Table 2: Veteran population by age at the end of the Korean War, 1956, at the beginning of the study, 1982, and at the end of the study, 1999

Age group	1956	1982	1999
15–19	20	0	0
20–24	3,950	0	0
25–29	7,940	0	0
30–34	3,352	0	0
35–39	1,235	0	0
40–44	520	0	0
45–49	215	2,448	0
50–54	106	7,090	0
55–59	32	3,605	0
60–64	10	1,173	411
65–69	1	464	4,688
70–74	0	178	3,809
75–79	0	59	1,032
80–84	0	20	282
85+	0	4	90
Ages 15 and over	**17,381**	**15,041**	**10,312**

Of the 17,814 male veterans who served in the ADF in Korea, 17,381 were alive at the end of the Korean War in 1956[1]. Of these veterans the total population at risk of developing cancer at the beginning of the study period (1982), after excluding veterans who had died, was calculated to be 15,041 (Table 2). In this population, 884 veterans had not been in contact with

[1] This number includes all veterans who left Korea alive after their service but excludes those with missing date of birth and date of death.

DVA since the Korean War, and were not found on the Australian Electoral Roll. For these veterans, it was therefore not possible to determine whether they were still alive and residing in Australia or if they had died or moved permanently overseas. This group is referred to as the 'veterans whose status is unknown' for the purpose of this study.

To identify the impact of the veterans whose status is unknown, the veteran population at risk was estimated using two Scenarios:

- Scenario 1 excludes veterans whose status is unknown from the at-risk population. The effect of excluding veterans whose status is unknown is that the expected number of veterans with cancer may be under-estimated if some of these veterans are still alive and residing in Australia.
- Scenario 2 includes veterans whose status is unknown in the at-risk population, and assumes that they are still alive and residing in Australia. The effect of including veterans whose status is unknown is that the expected number of veterans with cancer may be over-estimated. This is because the veteran population under Scenario 2 is not adjusted for their possible death or migration out of Australia.

The findings from both Scenarios are presented in this report.

2.2.3 Observed cases of cancer in veterans compared with expected cases

The actual number of cancers experienced by the veteran population (observed cases) was compared to the expected number, by dividing the former figure by the latter. The resulting ratio (standardised incidence ratio) is above one if the actual cases of cancer among the veterans are higher than the expected number, and vice versa.

Table 1 illustrates how the standardised incidence ratio is calculated. In Table 1 there are nine new cases of head and neck cancer in 1999 which were identified by matching the living Korean War veteran population in 1999 to the NCSCH database. The expected number of cases of 5.3 in the fourth column is obtained by summing the expected number of cases for each age. The ratio of actual to expected cases of cancer in this example is 1.7 (9/5.3), which means that the veterans experienced 70% more cancers in 1999 than expected if they had experienced the same cancer incidence pattern as the total Australian community.

The process illustrated in Table 1 was repeated for each year from 1982 through to 1999. The results presented in this report are the comparison of the sum of the actual and expected cancers for the entire period 1982–1999. Comparison of annual numbers is less reliable due to the small number of cancers occurring in each year, and the resultant statistical instability in rates.

The standardised incidence ratio is not sufficient to say whether the veterans experienced higher or lower rates of cancer than might be expected. A statistical test is required to test whether the actual number of cancers experienced by veterans was statistically different from those expected. The test involves calculating a 95% confidence interval around the standardised incidence ratio.

Given that a standardised incidence ratio of 1.0 means that there is no difference in cancer incidence between Korean War veterans and the Australian community, a confidence interval which does not include 1.0 indicates a significant difference. For example, a standardised incidence ratio of 1.22 with a confidence interval of 1.02 to 1.42 is significantly different because the interval does not include 1.0. If the confidence interval was 0.92 to 1.52, the difference would not be significant because the confidence interval includes 1.0.

A mortar crew of 3 RAR in action at Pakchan, 5 November 1950. In the background is an M4A3E8 Sherman tank of the US Army. AWM 146949

A wounded Australian soldier is strapped into a litter on a US Army Bell Model 47D H-13B helicopter before his evacuation for medical treatment. AWM P1479/19

The officers of the watch taking a bearing during a patrol off the Korean coast, HMAS *Warramunga*, 1952. AWM 306774

3 Findings

This chapter examines the cancers diagnosed in Korean War veterans and compares the incidence of these cancers to the rates of cancer of the male population in Australia. The comparisons are only made for the cancers diagnosed in the period 1982–1999 because complete data on cancer incidence in Australia are only available from 1982. This means that cancers developed in the period between the war and 1982 are not considered in this study.

Notwithstanding this, the Study Consultative Committee requested that mention be made of cancers likely to have occurred prior to 1982 that would have been of concern to the study. Such cancers would include both acute myeloid leukaemia (AML) and melanoma.

Of these, AML in the period prior to 1982 was almost always fatal. Accordingly, incidences of AML during that period will form part of the data reported in the Korean War Veterans' Mortality Study.

Melanoma, however, if it is picked up early enough and removed surgically, can be cured. Thus while the Mortality Study will identify those who died from melanoma prior to 1982, it will miss those who developed it during that period and survived due to early intervention.

3.1 Observed cancers in Korean War veterans

Between 1982 and 1999, a total of 3,543 cancers were identified among the male Korean War veteran population. Of these, prostate and lung cancers stand out as the most common cancers among the Korean War veterans. The 15 most common cancers among Korean War veterans are presented in Table 3.

Table 3: Most common cancers among Korean War veterans, 1982–1999

Type of cancer	Number	Per cent of all cancers
Prostate	731	20.6
Lung	672	19.0
Colon	299	8.4
Melanoma	253	7.1
Rectum	220	6.2
Head & neck	190	5.4
Bladder	162	4.6
Unknown primary site	146	4.1
Stomach	98	2.8
Larynx	95	2.7
Non-Hodgkin's lymphoma	92	2.6
Kidney	88	2.5
Leukaemia	73	2.1
Oesophagus	72	2.0
Pancreas	61	1.7
Other cancers	289	8.2
All cancers	**3,543**	100.0

3.2 Korean War veterans' cancer experience compared to the Australian community

To determine whether Korean War veterans' experience of cancer differed from that of the Australian community, standardised cancer incidence ratios (SIR) were calculated for each cancer type, under the two population Scenarios described in Section 2.2.2:

- Scenario 1 excludes veterans whose status is unknown from the at-risk population. The effect of excluding veterans whose status is unknown is that the expected number of veterans with cancer may be under-estimated if some of these veterans are still alive and residing in Australia.

  Under this Scenario, the exclusion of 'unknown status' veterans from the population at risk will result in the relative cancer incidence of Korean War veterans compared with the Australian community being over-estimated, if some of these veterans are still alive and living in Australia.
- Scenario 2 includes veterans whose status is unknown in the at-risk population, and assumes that they are still alive and residing in Australia. The effect of including veterans whose status is unknown is that the expected number of veterans with cancer may be over-estimated. This is because the veteran population under Scenario 2 is not adjusted for their possible death or migration out of Australia.

  Under this Scenario, the inclusion of 'unknown status' veterans in the population at risk will result in the relative cancer incidence of Korean War veterans compared with the Australian community being under-estimated, if some of these veterans have died or migrated out of Australia.

Results from these two Scenarios provide an upper and lower standardised incidence ratio, depending on whether or not the 'unknown status' veterans are living in Australia.

3.2.1 Scenario 1 (excluding veterans whose status is unknown)

- Under this Scenario, when the observed numbers of cancers among the Korean War veterans were compared to the expected numbers, the incidence of cancer experienced by veterans was 23% higher than that of the Australian community (Figure 3 and Table 4).
- The incidence of cancers of the head & neck, melanoma, lung, larynx, prostate, colon, rectum and oesophagus was statistically significantly higher in the veteran population than in the Australian community.
- Compared to the Australian community, the incidence of head & neck cancers was 90% higher among the veteran population, larynx cancer was 72% higher, oesophagus cancer was 54% higher and lung cancer was 42% higher. Also, among veterans, cancer of the prostate was 18% higher, colon cancer was 15% higher, rectum cancer was 25% higher, and melanoma was 18% higher than the incidence of these cancers in the Australian community.
- Many of these cancers are regarded as smoking-related cancers because they are thought to be directly attributable in part to smoking. For example, based on the age specific aetiological fractions developed by Ridolfo & Stevenson (2001), smoking contributed to 51% of head & neck cancers, 51% of oesophagus cancers, 68% of larynx cancer and 89% of lung cancer in males in 1999.

- Head & neck cancer comprises all malignant cancers of the head & neck area except skin cancers, eye cancers and brain cancers. It includes cancers of the lip, tongue, salivary glands, gum, mouth, tonsils, oesophagus, ears, nasal passage and larynx.

3.2.2 Scenario 2 (including veterans whose status is unknown)

- When the veterans with unknown status were included in the study population, the pattern is similar to Scenario 1, with elevated rates in smoking-related cancers for Korean War veterans compared to the Australian community. However, the level of elevation is lower than for Scenario 1. The overall cancer experience of the veterans was also statistically significantly higher than the Australian community experience by 13%, compared with 23% for Scenario 1 (Figure 3 and Table 4).
- Veterans experienced 76% higher incidence of head & neck cancers, 60% higher incidence of larynx cancer, 42% higher incidence of oesophagus cancer and 31% higher lung cancer rates than experienced by the Australian community. Smoking is a major risk factor associated with all these cancers.

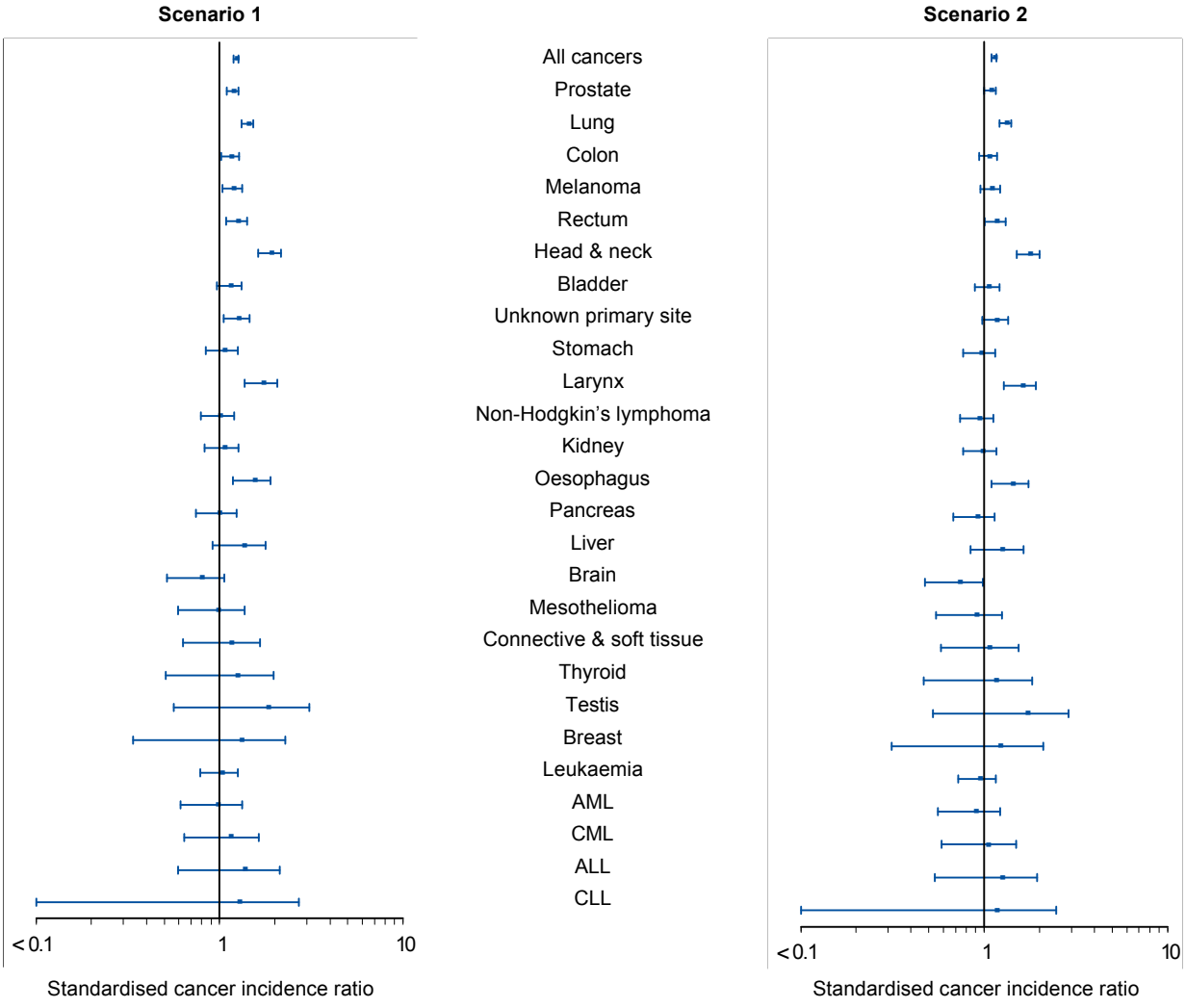

Figure 3: Standardised cancer incidence ratios and 95% confidence intervals for Korean War veterans, 1982–1999, by Scenario

Table 4: Observed and expected numbers of cancers for Korean War veterans and the standardised cancer incidence ratio (SIR), 1982–1999

		Scenario 1 (excluding veterans whose status is unknown)			Scenario 2 (including veterans whose status is unknown)		
Type of cancer	Observed number	Expected number	Ratio[(a)]	95% confidence interval	Expected number	Ratio[(a)]	95% confidence interval
All cancers	***3,543***	***2,877***	***1.23***	***1.19–1.27***	***3,128***	***1.13***	***1.10–1.17***
Prostate	731	619	1.18	1.09–1.27	678	1.08	1.00–1.16
Lung	672	474	1.42	1.31–1.52	515	1.31	1.21–1.40
Colon	299	260	1.15	1.02–1.28	283	1.06	0.94–1.18
Melanoma	253	215	1.18	1.03–1.32	232	1.09	0.95–1.22
Rectum	220	175	1.25	1.09–1.42	190	1.16	1.00–1.31
Head & neck	190	100	1.90	1.63–2.17	108	1.76	1.51–2.01
Bladder	162	142	1.14	0.96–1.31	155	1.05	0.88–1.21
Unknown primary site	146	116	1.26	1.06–1.47	126	1.16	0.97–1.35
Stomach	98	94	1.05	0.84–1.25	102	0.96	0.77–1.15
Larynx	95	55	1.72	1.38–2.07	60	1.60	1.28–1.92
Non-Hodgkin's lymphoma	92	92	1.00	0.80–1.21	99	0.93	0.74–1.11
Kidney	88	84	1.05	0.83–1.27	91	0.97	0.77–1.17
Oesophagus	72	47	1.54	1.18–1.89	51	1.42	1.09–1.74
Pancreas	61	61	0.99	0.74–1.24	67	0.91	0.68–1.14
Liver	37	27	1.35	0.91–1.78	30	1.24	0.84–1.64
Brain	32	40	0.79	0.52–1.07	44	0.73	0.48–0.99
Mesothelioma	25	25	0.98	0.60–1.37	28	0.90	0.55–1.26
Connective & soft tissue	19	17	1.15	0.63–1.67	18	1.06	0.58–1.54
Thyroid	11	9	1.24	0.51–1.97	10	1.15	0.47–1.83
Testis	7	4	1.83	0.56–3.10	5	1.71	0.52–2.89
Breast	8	5	1.31	0.34–2.28	6	1.21	0.31–2.10
Leukaemia	73	71	1.02	0.79–1.26	78	0.94	0.72–1.16
Chronic lymphocytic leukemia (CLL)	29	30	0.97	0.61–1.32	33	0.89	0.57–1.21
Acute myeloid leukemia (AML)	20	18	1.14	0.64–1.63	19	1.04	0.58–1.50
Chronic myeloid leukemia (CML)	12	9	1.36	0.59–2.12	10	1.24	0.54–1.95
Acute lymphoblastic leukemia (ALL)	3	2	1.27	0.00–2.70	3	1.16	0.00–2.48

(a) The expected numbers used to calculate the ratios are unrounded numbers, rather than the integers shown in the table.

Note: The shaded rows indicate that the incidence of these cancers is significantly higher among Korean War veterans than in the general Australian population.

3.3 Contribution of smoking to smoking-related cancers

Given the high standardised incidence ratios in smoking-related cancers, an analysis was conducted to examine if smoking alone could explain all of the elevation in the smoking-related cancers in Korean War veterans.

Literature on Korean War veterans' living conditions during the war indicated that extensive cigarette smoking took place, particularly among Army personnel, under confined and poorly ventilated living conditions in the latter part of the war. Cigarettes were freely available in large quantities to all ADF personnel engaged in Korea.

However, the actual prevalence of smoking amongst Korean War veterans is unknown either during the conflict or afterwards. While there is anecdotal evidence of high levels of smoking during the conflict and knowledge of the cigarette rations, there was no systematic measurement of smoking rates. Therefore this analysis provides for a range of smoking prevalence of 30–100% and generates a hypothetical number of expected cases based on these prevalence rates and estimates of attributable risk of cancer due to smoking (Table 5). Appendix A provides an explanation of the method used to derive the estimated cancer rates at various levels of prevalence.

A comparison of the expected cases of smoking-related cancers with the actual number of cases among veterans shows that head & neck cancer is the only smoking-related cancer where the elevated rates for Korean War veterans could not be fully explained by smoking. For both Scenarios, even if 100% of veterans had smoked, the actual number of cases of head & neck cancer was still higher than the expected number of cases. This indicates additional factors to smoking may have caused the elevated rates of head & neck cancer among Korean War veterans.

Of the other smoking-related cancers found to be elevated in Korean War veterans, the elevated rates could be attributed to smoking if it can be accepted that veterans had a higher prevalence of smoking than that found in the Australian community. For smoking to be the sole cause of the elevated rates, levels of smoking prevalence among veterans for each smoking-related cancer would have to be:

- oesophagus—86% smoking (Scenario 1) and 77% smoking (Scenario 2), that is, for the expected number of cases of oesophagus cancer to equal the actual number of cases of 72, veterans would have required smoking rates of 86% for Scenario 1 and 77% for Scenario 2;
- stomach—60% smoking (Scenario 1) and 33% smoking (Scenario 2);
- larynx—90% smoking (Scenario 1) and 82% smoking (Scenario 2); and
- lung—64% smoking (Scenario 1) and 59% smoking (Scenario 2).

Pancreatic cancer was the sole smoking-related cancer where no significant difference was found in the rates between Korean War veterans and the Australian community.

Table 5: Expected cancers among Korean War veterans assuming various levels of smoking prevalence

Type of cancer	Smoking risk ratio	Actual cases	Expected cases	Ratio	95% confidence interval	Expected cases							
						Smoking prevalence (%)							
						30	40	50	60	70	80	90	100
					Scenario 1								
Oesophagus	4.01	72	47	1.54	1.18–1.89	38	44	50	56	62	68	75	81
Stomach	1.41	98	94	1.05	0.84–1.25	89	92	95	98	102	105	108	111
Head & neck	4.55	190	100	1.90	1.63–2.17	79	92	106	119	133	146	160	173
Pancreas	1.86	61	61	0.99	0.74–1.24	56	60	64	68	71	75	79	83
Larynx	7.48	95	55	1.72	1.38–2.07	41	50	59	68	77	86	95	104
Lung	30.00	672	474	1.42	1.31–1.52	331	430	529	628	727	826	924	1,023
					Scenario 2								
Oesophagus	4.01	72	51	1.42	1.09–1.74	42	48	55	61	68	74	81	88
Stomach	1.41	98	102	0.96	0.77–1.15	97	100	104	107	111	114	118	121
Head & neck	4.55	190	108	1.76	1.51–2.01	85	99	114	128	143	158	172	187
Pancreas	1.86	61	67	0.91	0.68–1.14	61	65	69	74	78	82	86	90
Larynx	7.48	95	60	1.60	1.28–1.92	44	54	63	73	83	93	102	112
Lung	30.00	672	515	1.31	1.21–1.40	360	467	575	683	790	898	1,005	1,113

3.4 Cancer in veterans by type of Service

Cases of cancer among Korean War veterans were further classified by type of Service (Navy, Army and RAAF) to explore any relationship to type of Service. Again the analyses were done using the two population Scenarios (Tables 6–8). A selected group of cancers that were significantly higher than that expected in at least one type of service is presented in Figure 4.

3.4.1 Scenario 1 (excluding veterans whose status is unknown)

Navy

- Total cancer incidence was statistically significantly higher among veterans who served in the Navy during the Korean War, being 25% higher than for the Australian community (Table 6).
- Navy veterans also experienced prostate (30% higher), lung (25% higher) and head & neck (93% higher) cancers at a rate significantly higher than expected, based on the cancer incidence experienced by the Australian community.

Army

- Among those veterans who served in the Army, the observed cases of all cancers were 25% higher than expected and was statistically significantly higher than the experience of the Australian community (Table 7).
- The observed incidence of lung cancer among those who served in the Army was 59% higher than that of the Australian community, head & neck cancers were 91% higher, and cancer of the larynx was more than 100% higher. In addition, the incidence of liver cancer among Korean War veterans who served in the Army was 78% higher than for the Australian community, rectum cancer was 22% higher and oesophagus cancer was 52% higher. All the above elevated rates were statistically significant.

RAAF

- Veterans who served in the RAAF showed no difference in the incidence of total cancer compared to the Australian community. However, they showed higher rates of prostate, rectum, bladder, melanoma and head & neck cancers than for the Australian community, but only melanoma cancer was statistically significantly higher (Table 8).

3.4.2 Scenario 2 (including veterans whose status is unknown)

Navy

- The Navy personnel experienced 17% higher rates of total cancer than the Australian community. Lung and head & neck cancers observed among veterans who served in the Navy were also significantly higher (17% and 81% respectively) than that expected. Prostate cancer was also 20% higher than expected among the Navy veterans (Table 6).

Army

- Observed cases of all cancers were 13% higher among veterans who served in the Army, compared to the expected number of all cancers based on the experience of the Australian community (Table 7).
- Compared to the numbers expected, lung cancer was 44% higher, head & neck cancers were 74% higher, larynx cancer was 87% higher and liver cancer was 61% higher among those who served in the Army.

RAAF

- Veterans who served in the RAAF experienced significantly high incidence of melanoma cancer (64% higher), compared to the Australian community (Table 8).

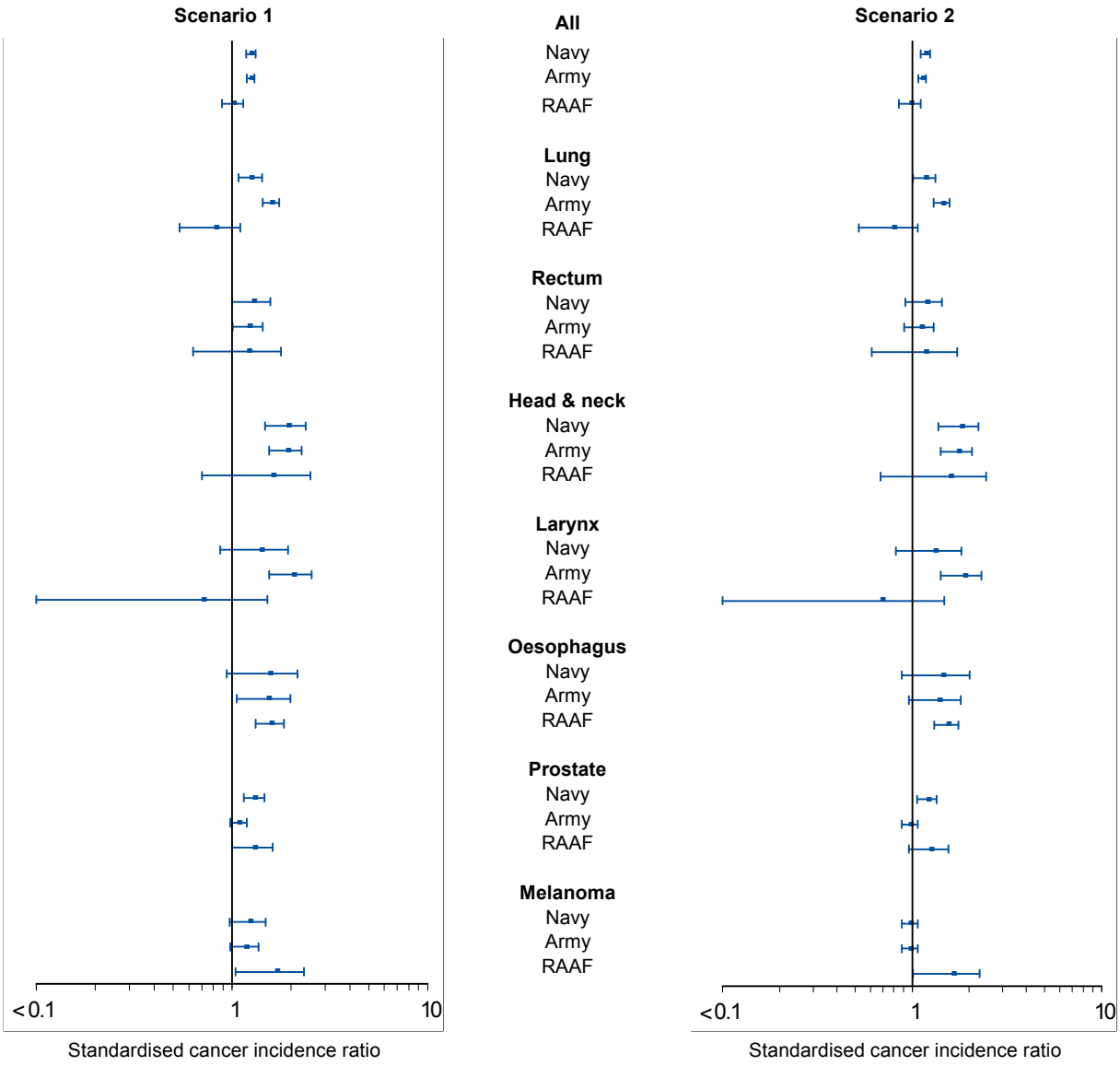

Figure 4: Standardised cancer incidence ratios and 95% confidence intervals for veterans, by service type, 1982–1999

Table 6: Observed and expected numbers of cancers for Korean War veterans who served in the Navy, and the standardised cancer incidence ratio (SIR), 1982–1999

		Scenario 1 (excluding veterans whose status is unknown)			Scenario 2 (including veterans whose status is unknown)		
Type of cancer	Observed number	Expected number	Ratio[(a)]	95% confidence interval	Expected number	Ratio[(a)]	95% confidence interval
All cancers	***1,238***	***988***	***1.25***	***1.18–1.32***	***1,057***	***1.17***	***1.11–1.24***
Prostate	274	211	1.30	1.15–1.46	228	1.20	1.06–1.35
Lung	203	162	1.25	1.08–1.42	174	1.17	1.01–1.33
Colon	110	90	1.23	1.00–1.46	97	1.13	0.94–1.37
Melanoma	92	75	1.23	0.97–1.48	75	1.23	0.98–1.48
Rectum	78	61	1.28	1.00–1.57	66	1.18	0.92–1.44
Head & neck	68	35	1.93	1.47–2.39	38	1.81	1.38–2.24
Bladder	63	48	1.31	0.99–1.63	52	1.22	0.92–1.52
Unknown primary site	52	42	1.23	0.90–1.57	45	1.15	0.84–1.46
Stomach	33	32	1.04	0.69–1.40	34	0.97	0.64–1.31
Non-Hodgkin's lymphoma	32	29	1.11	0.73–1.50	31	1.04	0.68–1.41
Kidney	31	29	1.07	0.69–1.44	31	1.00	0.65–1.35
Larynx	27	19	1.40	0.87–1.93	21	1.31	0.82–1.81
Pancreas	25	21	1.20	0.73–1.66	22	1.11	0.68–1.55
Oesophagus	25	16	1.55	0.94–2.16	17	1.44	0.88–2.01
Mesothelioma	14	8	1.75	0.83–2.67	9	1.64	0.78–2.50
Brain	13	14	0.92	0.42–1.42	15	0.87	0.40–1.34
Liver	9	10	0.94	0.32–1.55	10	0.88	0.31–1.46
Connective & soft tissue	7	6	1.22	0.32–2.13	6	1.15	0.30–2.00
Thyroid	5	3	1.59	0.20–2.98	3	1.50	0.19–2.82
Testis	3	2	1.94	0.00–4.14	2	1.84	0.00–3.92
Breast	1	2	0.54	0.00–1.60	2	0.51	0.00–1.51
Leukaemia	26	22	1.25	0.74–1.60	23	1.17	0.69–1.55
Chronic lymphocytic leukaemia	10	9	1.22	0.42–1.80	10	1.04	0.40–1.69
Acute myeloid leukaemia	7	5	1.30	0.34–2.26	6	1.21	0.31–2.11
Chronic myeloid leukaemia	5	3	1.70	0.21–3.18	3	1.72	0.21–3.24
Acute lymphoblastic leukaemia	2	1	2.47	0.00–5.90	1	2.53	0.00–6.04

(a) The expected numbers used to calculate the ratios are unrounded numbers, rather than the integers shown in the table.

Note: The shaded rows indicate that the incidence of these cancers is significantly higher among Korean War veterans than in the general Australian population.

Table 7: Observed and expected numbers of cancers for Korean War veterans who served in the Army, and the standardised cancer incidence ratio (SIR), 1982–1999

		Scenario 1 (excluding veterans whose status is unknown)			Scenario 2 (including veterans whose status is unknown)		
Type of cancer	Observed number	Expected number	Ratio[(a)]	95% confidence interval	Expected number	Ratio[(a)]	95% confidence interval
All cancers	***2,066***	***1,655***	***1.25***	***1.19–1.30***	***1,831***	***1.13***	***1.08–1.18***
Lung	435	274	1.59	1.44–1.74	302	1.44	1.30–1.57
Prostate	387	357	1.08	0.98–1.19	398	0.97	0.88–1.07
Colon	172	152	1.13	0.96–1.30	168	1.02	0.87–1.18
Melanoma	135	115	1.17	0.98–1.37	127	1.07	0.89–1.25
Rectum	125	102	1.22	1.01–1.43	113	1.11	0.91–1.30
Head & neck	110	58	1.91	1.55–2.26	63	1.74	1.41–2.07
Unknown primary site	91	72	1.27	1.01–1.53	79	1.15	0.91–1.38
Bladder	85	82	1.03	0.81–1.25	91	0.93	0.73–1.13
Larynx	65	32	2.05	1.55–2.55	35	1.87	1.41–2.32
Stomach	59	54	1.09	0.81–1.37	60	0.99	0.73–1.24
Non-Hodgkin's lymphoma	53	48	1.11	0.81–1.40	53	1.00	0.73–1.27
Kidney	51	48	1.06	0.77–1.35	53	0.96	0.70–1.22
Oesophagus	41	27	1.52	1.06–1.99	30	1.38	0.96–1.80
Pancreas	33	36	0.93	0.61–1.24	39	0.84	0.55–1.12
Liver	28	16	1.78	1.12–2.43	17	1.61	1.01–2.20
Brain	16	23	0.69	0.35–1.02	26	0.62	0.32–0.93
Connective soft tissue	12	10	1.26	0.55–1.97	11	1.14	0.50–1.79
Mesothelioma	11	13	0.83	0.34–1.32	15	0.75	0.31–1.20
Thyroid	6	5	1.18	0.24–2.12	6	1.07	0.21–1.93
Breast	5	3	1.62	0.20–3.05	3	1.47	0.18–2.76
Testis	4	3	1.58	0.03–3.13	3	1.46	0.03–2.89
Leukaemia	42	37	1.14	0.80–1.49	41	1.03	0.72–1.34
Chronic lymphocytic leukaemia	17	15	1.13	0.59–1.66	17	1.02	0.53–1.50
Acute myeloid leukaemia	11	9	1.21	0.49–1.92	10	1.09	0.45–1.73
Chronic myeloid leukaemia	7	5	1.49	0.39–2.59	5	1.34	0.35–2.33
Acute lymphoblastic leukaemia	1	1	0.80	0.00–2.37	1	0.72	0.00–2.14

(a) The expected numbers used to calculate the ratios are unrounded numbers, rather than the integers shown in the table.

Note: The shaded rows indicate that the incidence of these cancers is significantly higher among Korean War veterans than in the general Australian population.

Table 8: Observed and expected numbers of cancers for Korean War veterans who served in the RAAF, and the standardised cancer incidence ratio (SIR), 1982–1999

		Scenario 1 (excluding veterans whose status is unknown)			Scenario 2 (including veterans whose status is unknown)		
Type of cancer	Observed number	Expected number	Ratio[(a)]	95% confidence interval	Expected number	Ratio[(a)]	95% confidence interval
All cancers	***239***	***236***	***1.01***	***0.89–1.14***	***244***	***0.98***	***0.86–1.11***
Prostate	70	54	1.30	1.00–1.61	56	1.25	0.96–1.55
Lung	32	39	0.82	0.54–1.10	40	0.79	0.52–1.07
Melanoma	26	15	1.68	1.04–2.33	16	1.64	1.01–2.27
Colon	17	21	0.79	0.42–1.17	22	0.77	0.40–1.13
Rectum	17	14	1.21	0.63–1.78	15	1.17	0.61–1.73
Bladder	14	12	1.16	0.55–1.76	13	1.12	0.53–1.70
Head & neck	12	7	1.61	0.70–2.51	8	1.57	0.68–2.45
Non-Hodgkin's lymphoma	7	7	1.04	0.27–1.82	7	1.01	0.26–1.76
Stomach	6	8	0.76	0.15–1.37	8	0.74	0.15–1.32
Kidney	6	7	0.90	0.18–1.63	7	0.88	0.18–1.58
Oesophagus	6	4	1.58	0.32–2.84	4	1.53	0.31–2.75
Pancreas	3	5	0.59	0.00–1.25	5	0.56	0.00–1.20
Brain	3	3	0.96	0.00–2.05	3	0.94	0.00–2.00
Unknown primary site	3	10	0.29	0.00–0.62	11	0.28	0.00–0.59
Larynx	3	4	0.71	0.00–1.52	4	0.69	0.00–1.48
Testis	1	0	3.39	0.00–10.03	0	3.31	0.00–9.80
Breast	1	0	2.31	0.00–6.84	0	2.24	0.00–6.62
Liver	0	2	0.00	0.00–0.00	2	0.00	0.00–0.00
Mesothelioma	0	2	0.00	0.00–0.00	2	0.00	0.00–0.00
Connective & soft tissue	0	1	0.00	0.00–0.00	1	0.00	0.00–0.00
Thyroid	0	1	0.00	0.00–0.00	1	0.00	0.00–0.00
Leukaemia	5	5	0.94	0.12–1.76	6	0.90	0.11–1.70
Acute myeloid leukaemia	2	1	1.51	0.00–3.59	1	1.45	0.00–3.47
Chronic lymphocytic leukaemia	2	2	0.93	0.00–2.22	2	0.90	0.00–2.15
Chronic myeloid leukaemia	0	1	0.00	0.00–0.00	1	0.00	0.00–0.00
Acute lymphoblastic leukaemia	0	0	0.00	0.00–0.00	0	0.00	0.00–0.00

(a) The expected numbers used to calculate the ratios are unrounded numbers, rather than the integers shown in the table.

Note: The shaded rows indicate that the incidence of these cancers is significantly higher among Korean War veterans than in the general Australian population.

3.5 Korean War veterans cancer incidence by Service type and duration of service

This section explores whether the duration of service of the Navy and Army veterans in Korea had an association with cancer rates. The duration of service in days is divided into three categories (short, medium and long duration) to reflect natural divisions in the duration of service. This division allows the mean duration of service to be substantially different in each category. The veterans' cancer experience under each duration of service category was compared, under both population Scenarios, to the expected number based on the cancer rates of the Australian community.

The analysis of cancer incidence by duration of service was not performed for RAAF veterans due to insufficient numbers of cancers leading to unstable estimates.

Overall, the Navy veterans served in Korea for a shorter period than the Army veterans. Because of this difference, the categories of duration of service used in the following analyses are different for Navy and Army (Table 9).

Table 9: Categories of duration of service for Navy and Army veterans

	Duration category					
	Short		Medium		Long	
Service type	Days	No. of veterans	Days	No. of veterans	Days	No. of veterans
Navy	1–174	430	175–294	3,784	295+	888
Army	1–345	4,189	346–389	3,657	390+	1,088

Note: Number of veterans in table includes the veterans whose status is unknown.

3.5.1 Scenario 1 (excluding veterans whose status is unknown)

Navy personnel who served in Korea

- Small numbers of Navy veterans in the short and long duration categories and the corresponding small numbers of cancers to these veterans mean that valid comparisons across duration categories are not possible. Standardised incidence ratios for the short and long duration categories have confidence intervals too wide to identify any significant differences from the standardised incidence ratios of the medium category. The results of the analysis, however, are presented in Tables 10–12. A selection of cancers that were significantly higher than expected is presented in Figure 5.
- The medium duration category is the only category with numbers large enough to show statistically significant differences in cancer incidence compared to the Australian community. This group shows similar differences to the total Navy veteran group. The incidence of all cancers is 28% higher than for the Australian community, while specific cancers showing significantly higher incidence are head & neck (116% higher), lung (35% higher), prostate (34% higher) and melanoma (33% higher).

Army personnel who served in Korea

- The observed incidence of all cancers among Army veterans was lowest for those who served in Korea for a short duration, but was still 21% higher than the incidence in the

Australian community. The observed incidence increased to 28% higher than in the Australian community for Army veterans who served for a medium duration and 26% higher for a long duration (Tables 13–15). A selection of cancers that were significantly higher than expected is presented in Figure 6.

- The incidence of lung cancer, larynx cancer and head & neck cancer increased among veterans who served in the Army during the Korean War, as the duration of service in Korea increased from short to medium (Tables 13–15). However, of these cancers, only head & neck cancer showed a higher incidence for Army veterans who served in Korea for a long duration, compared with the veterans who served for a medium duration.
- The incidence of lung cancer observed was significantly higher (43%) than in the Australian community among Korean War veterans who served in the Army for a short duration. This difference increased to be 75% higher among those who served in Korea for a medium duration, and 67% higher among those who served in Korea for a long duration.
- Larynx cancer incidence among veterans who served in Korea for a short duration is significantly higher (85%) than the expected incidence. As the duration of service increased from short to medium the observed incidence of larynx cancer increased from 85% to 126% higher than the Australian community. The observed incidence of larynx cancer was 102% higher than the expected number among those who served in Korea for a long duration.
- The observed head & neck cancer incidence progressively increased as the duration of service increased from short to long. Among veterans who served in Korea in the short duration of service category, the observed incidence of head & neck cancer was 73% higher than expected. Among those who served in Korea in the medium duration category, the observed number of head & neck cancers was 98% higher than expected while those veterans who served in Korea longest experienced 122% more head & neck cancers than expected.

3.5.2 Scenario 2 (including veterans whose status is unknown)

Navy personnel who served in Korea

- As with Scenario 1, the medium duration category is the only category with numbers of cancers large enough to show statistically significant differences in cancer incidence compared to the Australian community. This group shows similar differences to the total Navy veteran group. The incidence of all cancers is 20% higher than for the Australian community, while specific cancers showing significantly higher incidence are head & neck (104% higher), lung (26% higher) and prostate (25% higher). The observed incidence of melanoma cancer was 25% higher than expected but this excess was not statistically significant (Tables 10–12).

Army personnel who served in Korea

- Similar to the population Scenario 1, the observed incidence of all cancers, lung, larynx and head & neck cancers consistently increased as the duration of veterans' service in Korea increased from low to medium. The observed incidence of head & neck cancer continued to be higher than expected as the duration of service increased.

- Compared to the numbers expected, a significantly high incidence of all cancers (10% higher) was observed among Army personnel who served in Korea for a short duration. Those who served in Korea for a medium duration experienced 16% more cancers overall than expected, based on the Australian community standard. Although 13% more all cancers were observed among those who served longer in Korea, insufficient number of veterans in this group meant that the excess is not statistically significant (Tables 13–15).
- The observed number of lung cancers was 30% higher than expected among those who served in Korea for a short duration. It was 58% higher among those who served in Korea for a medium duration and 50% higher among those who served in Korea for a long duration.
- Head & neck cancers among veterans in the short duration of service category was 58% higher than the expected number and this rose to 81% as the duration of service of Army veterans who served in Korea increased from short to medium. This upward trend continued to be present when the duration of service increased to the high category, where the observed incidence of head & neck cancer was 103% higher than expected.
- Army veterans who served in Korea for short and medium durations experienced 70% and 106% more larynx cancer respectively than the expected numbers based on the Australian community standard.

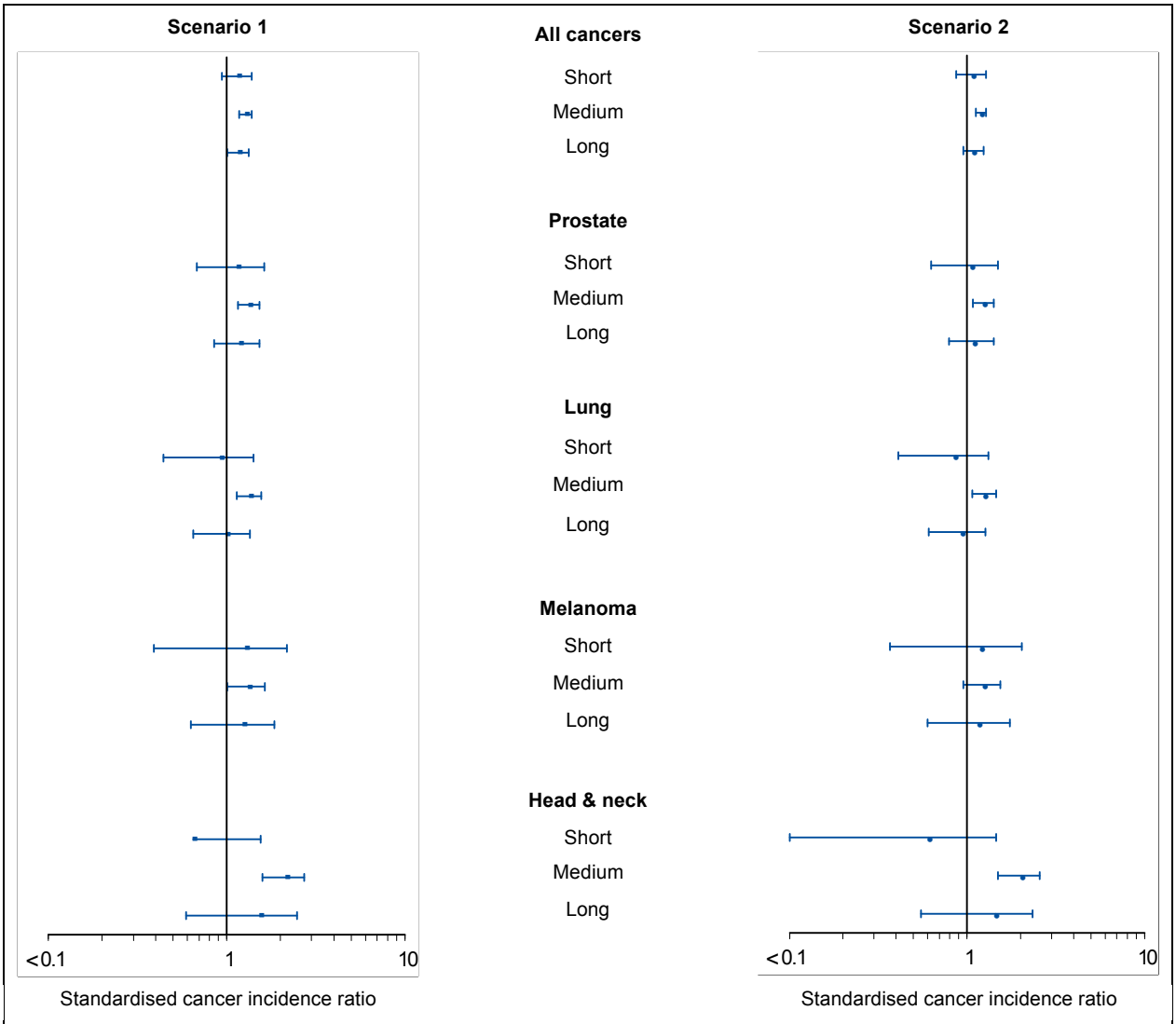

Figure 5: Standardised cancer incidence ratios and 95% confidence intervals for Navy Korean War veterans, by service duration category, 1982–1999

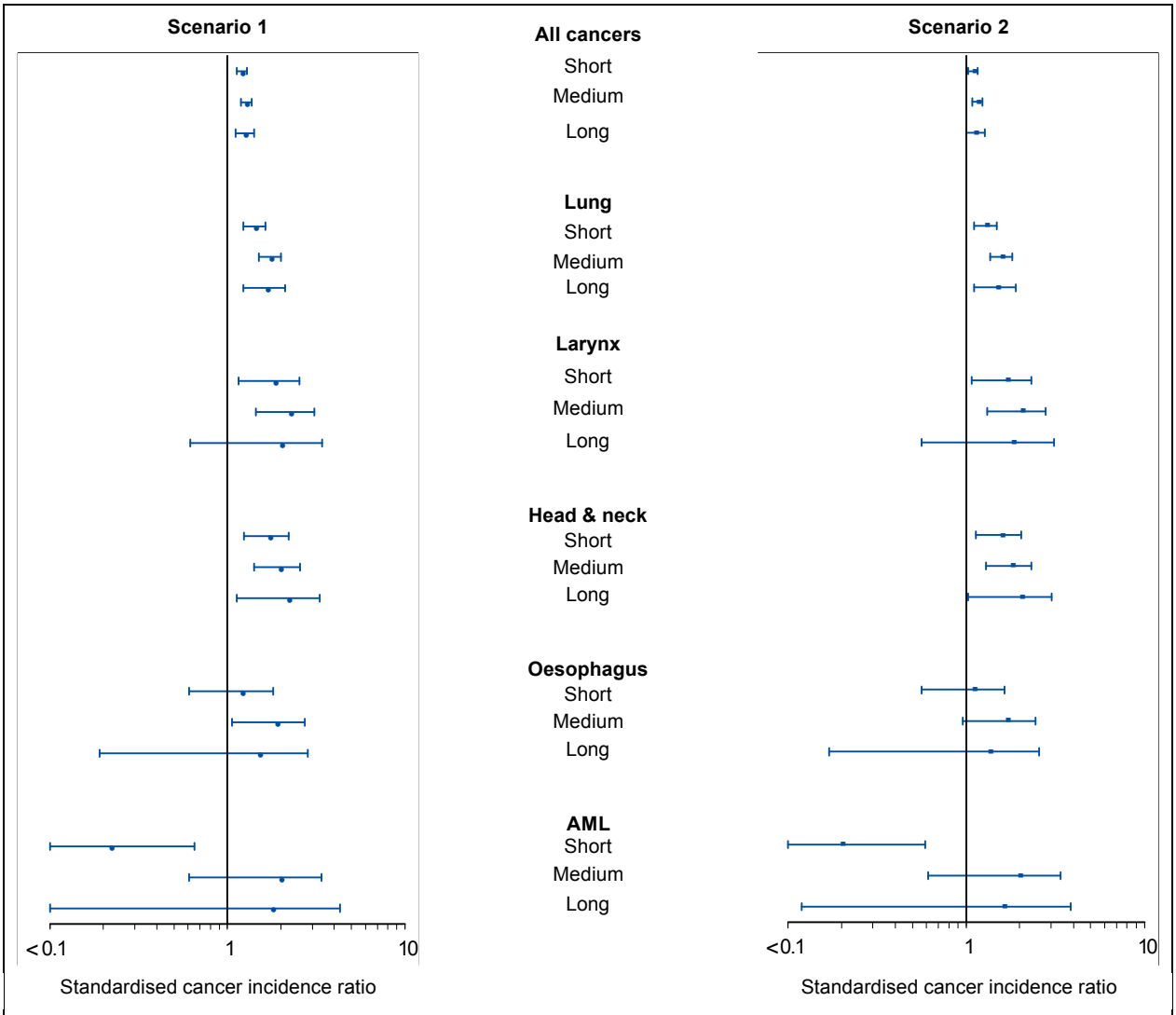

Figure 6: Standardised cancer incidence ratios and 95% confidence intervals for Army Korean War veterans, by service duration category, 1982–1999

Table 10: Observed and expected numbers of cancers and the standardised cancer incidence ratio (SIR) for Navy veterans who served in Korea in the short duration of service category, 1982–1999

		Scenario 1 (excluding veterans whose status is unknown)			Scenario 2 (including veterans whose status is unknown)		
Type of cancer	Observed number	Expected number	Ratio[(a)]	95% confidence interval	Expected number	Ratio[(a)]	95% confidence interval
All cancers	***105***	***91***	***1.16***	***0.94–1.38***	***97***	***1.08***	***0.87–1.28***
Prostate	23	20	1.15	0.68–1.62	22	1.06	0.63–1.50
Lung	14	15	0.93	0.44–1.41	16	0.86	0.41–1.32
Bladder	11	5	2.44	1.00–3.88	5	2.27	0.93–3.61
Colon	9	8	1.09	0.38–1.79	9	1.01	0.35–1.67
Melanoma	8	6	1.28	0.39–2.17	7	1.20	0.37–2.04
Rectum	6	6	1.08	0.22–1.94	6	1.01	0.20–1.81
Stomach	5	3	1.71	0.21–3.21	3	1.59	0.20–2.98
Pancreas	4	2	2.06	0.04–4.09	2	1.92	0.04–3.80
Oesophagus	4	1	2.68	0.05–5.31	2	2.50	0.05–4.94
Unknown primary site	3	4	0.77	0.00–1.64	4	0.72	0.00–1.53
Kidney	3	3	1.14	0.00–2.44	3	1.07	0.00–2.28
Head & neck	2	3	0.65	0.00–1.55	3	0.61	0.00–1.46
Non-Hodgkin's lymphoma	1	3	0.38	0.00–1.13	3	0.36	0.00–1.06
Brain	1	1	0.80	0.00–2.37	1	0.75	0.00–2.23
Mesothelioma	1	1	1.38	0.00–4.07	1	1.29	0.00–3.81
Connective & soft tissue	1	1	1.96	0.00–5.80	1	1.83	0.00–5.43
Larynx	0	2	0.00	0.00–0.00	2	0.00	0.00–0.00
Liver	0	1	0.00	0.00–0.00	1	0.00	0.00–0.00
Thyroid	0	0	0.00	0.00–0.00	0	0.00	0.00–0.00
Breast	0	0	0.00	0.00–0.00	0	0.00	0.00–0.00
Testis	0	0	0.00	0.00–0.00	0	0.00	0.00–0.00
Leukaemia	1	2	0.50	0.00–1.49	2	0.47	0.00–1.38
Chronic lymphocytic leukaemia	1	1	1.23	0.00–3.64	1	1.15	0.00–3.40
Acute myeloid leukaemia	0	0	0.00	0.00–0.00	1	0.00	0.00–0.00
Chronic myeloid leukaemia	0	0	0.00	0.00–0.00	0	0.00	0.00–0.00
Acute lymphoblastic leukaemia	0	0	0.00	0.00–0.00	0	0.00	0.00–0.00

(a) The expected numbers used to calculate the ratios are unrounded numbers, rather than the integers shown in the table.

Table 11: Observed and expected numbers of cancers and the standardised cancer incidence ratio (SIR) for Navy veterans who served in Korea in the medium duration of service category, 1982–1999

		Scenario 1 (excluding veterans whose status is unknown)			Scenario 2 (including veterans whose status is unknown)		
Type of cancer	Observed number	Expected number	Ratio[(a)]	95% confidence interval	Expected number	Ratio[(a)]	95% confidence interval
All cancers	***916***	***714***	***1.28***	***1.20–1.37***	***763***	***1.20***	***1.12–1.28***
Prostate	203	151	1.34	1.16–1.53	163	1.25	1.08–1.42
Lung	158	117	1.35	1.14–1.56	125	1.26	1.07–1.46
Colon	78	66	1.18	0.92–1.45	70	1.11	0.86–1.36
Melanoma	68	51	1.33	1.01–1.64	55	1.25	0.95–1.54
Head & neck	56	26	2.16	1.59–2.72	27	2.04	1.50–2.57
Rectum	55	45	1.22	0.90–1.54	48	1.15	0.84–1.45
Unknown primary site	40	30	1.31	0.91–1.72	33	1.23	0.85–1.61
Bladder	43	35	1.24	0.87–1.61	37	1.16	0.81–1.50
Kidney	21	21	0.99	0.57–1.42	23	0.93	0.53–1.33
Non-Hodgkin's lymphoma	28	21	1.34	0.85–1.84	22	1.26	0.79–1.73
Stomach	22	23	0.96	0.56–1.36	24	0.90	0.52–1.27
Larynx	20	14	1.42	0.80–2.05	15	1.34	0.75–1.93
Pancreas	18	15	1.19	0.64–1.74	16	1.11	0.60–1.62
Oesophagus	14	12	1.20	0.57–1.83	12	1.12	0.53–1.71
Mesothelioma	12	6	2.08	0.90–3.25	6	1.94	0.84–3.04
Liver	9	7	1.30	0.45–2.14	7	1.21	0.42–2.01
Brain	10	10	0.97	0.37–1.57	11	0.91	0.35–1.48
Connective & soft tissue	5	4	1.20	0.15–2.25	4	1.13	0.14–2.11
Thyroid	5	2	2.17	0.27–4.07	2	2.05	0.25–3.84
Testis	2	1	1.70	0.00–4.05	1	1.62	0.00–3.86
Breast	1	1	0.74	0.00–2.20	1	0.70	0.00–2.07
Leukaemia	19	16	1.22	0.67–1.76	17	1.20	0.63–1.65
Chronic lymphocytic leukaemia	7	7	1.08	0.28–1.87	7	1.01	0.26–1.76
Acute myeloid leukaemia	6	4	1.54	0.31–2.78	4	1.44	0.29–2.59
Chronic myeloid leukaemia	3	2	1.55	0.00–3.31	2	1.45	0.00–3.09
Acute lymphoblastic leukaemia	2	1	3.68	0.00–8.79	1	3.45	0.00–8.23

(a) The expected numbers used to calculate the ratios are unrounded numbers, rather than the integers shown in the table.

Note: The shaded rows indicate that the incidence of these cancers is significantly higher among Korean War veterans than in the general Australian population.

Table 12: Observed and expected numbers of cancers and the standardised cancer incidence ratio (SIR) for Navy veterans who served in Korea in the long duration of service category, 1982–1999

		Scenario 1 (excluding veterans whose status is unknown)			Scenario 2 (including veterans whose status is unknown)		
Type of cancer	Observed number	Expected number	Ratio[(a)]	95% confidence interval	Expected number	Ratio[(a)]	95% confidence interval
All cancers	***217***	***186***	***1.17***	***1.01–1.32***	***198***	***1.09***	***0.95–1.24***
Prostate	48	40	1.19	0.85–1.52	43	1.10	0.79–1.42
Lung	31	31	1.00	0.65–1.36	33	0.94	0.61–1.27
Colon	23	17	1.35	0.80–1.90	18	1.26	0.75–1.78
Rectum	17	12	1.47	0.77–2.18	12	1.38	0.73–2.04
Melanoma	16	13	1.24	0.63–1.85	14	1.17	0.60–1.74
Head & neck	10	7	1.54	0.58–2.49	7	1.45	0.55–2.35
Oesophagus	7	3	2.30	0.60–4.00	3	2.15	0.56–3.74
Bladder	9	9	0.99	0.34–1.63	10	0.92	0.32–1.52
Kidney	7	5	1.29	0.33–2.25	6	1.21	0.31–2.11
Unknown primary site	9	8	1.13	0.39–1.87	8	1.06	0.37–1.75
Stomach	6	6	1.01	0.20–1.82	6	0.95	0.19–1.70
Non-Hodgkin's lymphoma	3	5	0.56	0.00–1.20	6	0.53	0.00–1.13
Larynx	7	4	1.94	0.50–3.37	4	1.82	0.47–3.18
Brain	2	3	0.77	0.00–1.85	3	0.73	0.00–1.73
Pancreas	3	4	0.76	0.00–1.62	4	0.71	0.00–1.52
Testis	1	0	3.92	0.00–11.61	0	3.72	0.00–11.00
Mesothelioma	1	2	0.66	0.00–1.96	2	0.62	0.00–1.84
Connective & soft tissue	1	1	0.95	0.00–2.82	1	0.89	0.00–2.65
Liver	0	2	0.00	0.00–0.00	2	0.00	0.00–0.00
Breast	0	0	0.00	0.00–0.00	0	0.00	0.00–0.00
Thyroid	0	1	0.00	0.00–0.00	1	0.00	0.00–0.00
Leukaemia	6	4	1.48	0.29–2.66	4	1.38	0.28–2.48
Chronic lymphocytic leukaemia	2	2	1.19	0.00–2.84	2	1.12	0.00–2.66
Chronic myeloid leukaemia	2	1	3.85	0.00–9.19	1	3.58	0.00–8.54
Acute myeloid leukaemia	1	1	0.98	0.00–2.91	1	0.92	0.00–2.72
Acute lymphoblastic leukaemia	0	0	0.00	0.00–0.00	0	0.00	0.00–0.00

(a) The expected numbers used to calculate the ratios are unrounded numbers, rather than the integers shown in the table.

Note: The shaded rows indicate that the incidence of these cancers is significantly higher among Korean War veterans than in the general Australian population.

Table 13: Observed and expected numbers of cancers and the standardised cancer incidence ratio (SIR) for Army veterans who served in Korea in the short duration of service category, 1982–1999

		Scenario 1 (excluding veterans whose status is unknown)			Scenario 2 (including veterans whose status is unknown)		
Type of cancer	Observed number	Expected number	Ratio[(a)]	95% confidence interval	Expected number	Ratio[(a)]	95% confidence interval
All cancers	***981***	***813***	***1.21***	***1.13–1.28***	***896***	***1.10***	***1.03–1.16***
Prostate	199	179	1.11	0.96–1.27	198	1.00	0.86–1.14
Lung	192	135	1.43	1.22–1.63	148	1.30	1.11–1.48
Colon	89	75	1.19	0.95–1.44	82	1.08	0.86–1.31
Melanoma	69	55	1.25	0.96–1.55	60	1.14	0.87–1.41
Rectum	59	50	1.19	0.89–1.50	54	1.08	0.81–1.36
Head & neck	47	27	1.73	1.23–2.22	30	1.58	1.13–2.04
Unknown primary site	42	36	1.18	0.82–1.53	39	1.07	0.74–1.39
Bladder	39	41	0.95	0.65–1.24	45	0.86	0.59–1.13
Stomach	33	27	1.22	0.80–1.63	30	1.11	0.73–1.48
Non-Hodgkin's lymphoma	30	23	1.28	0.82–1.74	26	1.17	0.75–1.58
Larynx	28	15	1.85	1.17–2.54	17	1.70	1.07–2.32
Kidney	27	23	1.16	0.72–1.59	26	1.05	0.66–1.45
Pancreas	16	18	0.90	0.46–1.35	19	0.82	0.42–1.22
Oesophagus	16	13	1.21	0.62–1.81	15	1.10	0.56–1.64
Liver	14	8	1.85	0.88–2.82	8	1.68	0.80–2.56
Brain	7	11	0.63	0.16–1.09	12	0.57	0.15–1.00
Mesothelioma	5	6	0.78	0.10–1.47	7	0.71	0.09–1.33
Connective & soft tissue	5	5	1.08	0.13–2.02	5	0.98	0.12–1.84
Testis	2	1	1.70	0.00–4.06	1	1.57	0.00–3.74
Thyroid	2	2	0.83	0.00–1.97	3	0.76	0.00–1.80
Breast	1	2	0.66	0.00–1.96	2	0.60	0.00–1.79
Leukaemia	17	18	0.93	0.49–1.37	20	0.84	0.44–1.24
Chronic myeloid leukaemia	6	2	2.48	0.50–4.47	3	2.25	0.45–4.04
Chronic lymphocytic leukaemia	6	7	0.81	0.16–1.46	8	0.73	0.15–1.32
Acute myeloid leukaemia	1	5	0.22	0.00–0.65	5	0.20	0.00–0.59
Acute lymphoblastic leukaemia	0	1	0.00	0.00–0.00	1	0.00	0.00–0.00

(a) The expected numbers used to calculate the ratios are unrounded numbers, rather than the integers shown in the table.

Note: The shaded rows indicate that the incidence of these cancers is significantly higher among Korean War veterans than in the general Australian population.

Table 14: Observed and expected numbers of cancers and the standardised cancer incidence ratio (SIR) for Army veterans who served in Korea in the medium duration of service category, 1982–1999

		Scenario 1 (excluding veterans whose status is unknown)			Scenario 2 (including veterans whose status is unknown)		
Type of cancer	Observed number	Expected number	Ratio[(a)]	95% confidence interval	Expected number	Ratio[(a)]	95% confidence interval
All cancers	***828***	***647***	***1.28***	***1.19–1.37***	***717***	***1.16***	***1.08–1.23***
Lung	187	107	1.75	1.50–2.01	118	1.58	1.36–1.81
Prostate	131	136	0.96	0.80–1.13	152	0.86	0.71–1.01
Colon	65	60	1.09	0.82–1.35	66	0.98	0.75–1.22
Rectum	53	41	1.30	0.95–1.65	45	1.17	0.86–1.49
Melanoma	50	47	1.07	0.78–1.37	51	0.97	0.70–1.24
Head & neck	47	24	1.98	1.42–2.55	26	1.81	1.29–2.32
Unknown primary	39	28	1.41	0.97–1.86	31	1.28	0.88–1.68
Bladder	38	31	1.21	0.82–1.59	35	1.09	0.74–1.43
Larynx	29	13	2.26	1.44–3.08	14	2.06	1.31–2.80
Oesophagus	20	11	1.89	1.06–2.71	12	1.70	0.96–2.45
Kidney	19	19	0.99	0.54–1.43	21	0.89	0.49–1.30
Non-Hodgkin's lymphoma	18	19	0.95	0.51–1.39	21	0.86	0.46–1.26
Stomach	18	21	0.87	0.47–1.27	23	0.78	0.42–1.14
Pancreas	13	14	0.95	0.43–1.46	15	0.85	0.39–1.32
Liver	9	6	1.43	0.49–2.36	7	1.29	0.45–2.13
Brain	7	9	0.74	0.19–1.29	10	0.67	0.17–1.17
Connective & soft tissue	7	4	1.85	0.48–3.22	4	1.68	0.43–2.92
Mesothelioma	5	5	0.95	0.12–1.78	6	0.86	0.11–1.61
Thyroid	4	2	1.92	0.04–3.80	2	1.75	0.03–3.46
Breast	3	1	2.47	0.00–5.25	1	2.23	0.00–4.75
Testis	1	1	0.92	0.00–2.72	1	0.85	0.00–2.51
Leukaemia	20	14	1.41	0.79–2.03	16	1.27	0.71–1.83
Chronic lymphocytic leukaemia	9	6	1.52	0.53–2.51	7	1.37	0.48–2.27
Acute myeloid leukaemia	8	4	2.00	0.61–3.39	4	2.00	0.61–3.39
Chronic myeloid leukaemia	1	2	0.50	0.00–1.48	2	0.50	0.00–0.48
Acute lymphoblastic leukaemia	0	0	0.00	0.00–0.00	1	0.00	0.00–0.00

(a) The expected numbers used to calculate the ratios are unrounded numbers, rather than the integers shown in the table.

Note: The shaded rows indicate that the incidence of these cancers is significantly higher among Korean War veterans than in the general Australian population.

Table 15: Observed and expected numbers of cancers and the standardised cancer incidence ratio (SIR) for Army veterans who served in Korea in the long duration of service category, 1982–1999

		Scenario 1 (excluding veterans whose status is unknown)			Scenario 2 (including veterans whose status is unknown)		
Type of cancer	Observed number	Expected number	Ratio[(a)]	95% confidence interval	Expected number	Ratio[(a)]	95% confidence interval
All cancers	***255***	***202***	***1.26***	***1.11–1.41***	***225***	***1.13***	***1.00–1.27***
Prostate	57	43	1.31	0.97–1.66	49	1.17	0.87–1.48
Lung	56	34	1.67	1.23–2.10	37	1.50	1.11–1.90
Colon	18	19	0.97	0.52–1.41	21	0.87	0.47–1.27
Melanoma	16	14	1.12	0.57–1.67	16	1.02	0.52–1.52
Head & neck	16	7	2.22	1.13–3.31	8	2.03	1.03–3.02
Rectum	13	13	1.03	0.47–1.58	14	0.93	0.42–1.43
Unknown primary site	10	9	1.15	0.44–1.87	10	1.04	0.39–1.68
Bladder	8	10	0.80	0.25–1.36	11	0.72	0.22–1.22
Larynx	8	4	2.02	0.62–3.42	4	1.84	0.56–3.11
Stomach	8	7	1.22	0.38–2.07	7	1.10	0.34–1.86
Non-Hodgkin's lymphoma	5	6	0.85	0.11–1.60	6	0.77	0.10–1.45
Oesophagus	5	3	1.51	0.19–2.84	4	1.36	0.17–2.56
Kidney	5	6	0.84	0.10–1.58	7	0.76	0.09–1.43
Liver	5	2	2.53	0.31–4.75	2	2.29	0.28–4.29
Pancreas	4	4	0.93	0.02–1.84	5	0.83	0.02–1.65
Brain	2	3	0.69	0.00–1.66	3	0.63	0.00–1.51
Mesothelioma	1	2	0.61	0.00–1.81	2	0.55	0.00–1.64
Testis	1	0	3.21	0.00–9.49	0	2.97	0.00–8.78
Breast	1	0	2.67	0.00–7.91	0	2.42	0.00–7.15
Connective & soft tissue	0	1	0.00	0.00–0.00	1	0.00	0.00–0.00
Thyroid	0	1	0.00	0.00–0.00	1	0.00	0.00–0.00
Leukaemia	5	4	1.12	0.14–2.11	5	1.01	0.12–1.90
Acute myeloid leukaemia	2	1	1.80	0.00–4.30	1	1.62	0.00–3.86
Chronic lymphocytic leukaemia	2	2	1.08	0.00–2.58	2	0.98	0.00–2.34
Acute lymphoblastic leukaemia	1	0	0.00	0.00–0.00	0	0.00	0.00–0.00
Chronic myeloid leukaemia	0	1	0.00	0.00–0.00	1	0.00	0.00–0.00

(a) The expected numbers used to calculate the ratios are unrounded numbers, rather than the integers shown in the table.

Note: The shaded rows indicate that the incidence of these cancers is significantly higher among Korean War veterans than in the general Australian population.

3.6 Cancer mortality of Korean War veterans

This section gives a brief insight into the effect of incidence of cancer in veterans on their likelihood of dying. This is not an analysis of overall mortality experience of the Korean War veterans but an exploration of the cancers experienced by veterans that led to mortality during the study period, 1982–1999. The overall mortality experience of Korean War veterans is the subject of a separate study.

- A further analysis of the 3,543 cases of cancers diagnosed among 3,201 Korean War veterans during the period 1982–1999 shows that 1,886 (58.9%) of these veterans had died. Of those who died, the underlying cause of death in 71% of the deaths was the same cancer suffered by the veterans (Table 16).
- There were 669 veterans diagnosed with lung cancer during the period under study. Of those, 576 (86%) had died by 1999 and 89% of these deaths were due to lung cancer. On average, those veterans with lung cancer died within 2 years of diagnosis.
- Of the other smoking-related cancers, head & neck cancer contributed 59% of the deaths of veterans who had experienced this cancer, larynx cancer was responsible for 38% of the deaths of veterans with this cancer, and cancer of the oesophagus was the underlying cause in 80% of deaths of veterans who had this cancer.
- Colon cancer was the underlying cause of death in 71% of the colon cancer cases, while 43% of the veterans with rectum cancer died of the same cancer.
- Of the 73 veterans diagnosed with leukaemia, 63% had died during the study period. Leukaemia was responsible for 72% of the deaths of veterans who suffered from leukaemia.
- Other cancers that contributed significantly to deaths were pancreas, liver and brain cancers.

Table 16: Deaths of Korean War veterans diagnosed with cancer, by cancer incidence and cause of death, 1982–1999

	Veterans with cancer	Deaths of veterans diagnosed with cancer		Veterans died of the same cancer		Veterans still alive	
	Number[(a)]	Number	Per cent	Number	Per cent	Number	Per cent
All cancers	***3,201***	***1,886***	***58.9***	***1,337***	***70.9***	***1,315***	***41.1***
Prostate	730	238	32.6	112	47.1	492	67.4
Lung	669	576	86.1	512	88.9	93	13.9
Colon	297	139	46.8	99	71.2	158	53.2
Melanoma	253	84	33.2	34	40.5	169	66.8
Rectum	220	124	56.4	54	43.5	96	43.6
Head & neck	185	129	69.7	76	58.9	56	30.3
Bladder	159	70	44.0	28	40.0	89	56.0
Unknown primary site	146	130	89.0	83	63.8	16	11.0
Stomach	98	77	78.6	51	66.2	21	21.4
Larynx	94	45	47.9	17	37.8	49	52.1
Non-Hodgkin's Lymphoma	92	55	59.8	34	61.8	37	40.2
Kidney	88	51	58.0	34	66.7	37	42.0
Oesophagus	72	61	84.7	49	80.3	11	15.3
Pancreas	61	54	88.5	48	88.9	7	11.5
Liver	37	33	89.2	28	84.8	4	10.8
Brain	32	29	90.6	27	93.1	3	9.4
Mesothelioma	25	22	88.0	1	4.5	3	12.0
Connective & soft tissue	19	10	52.6	5	50.0	9	47.4
Thyroid	11	6	54.5	2	33.3	5	45.5
Testis	8	5	62.5	3	60.0	3	37.5
Breast	7	3	42.9	2	66.7	4	57.1
Leukaemia	73	46	63.0	33	71.7	27	37.0
Chronic lymphocytic leukaemia	29	14	48.3	8	57.1	15	51.7
Acute myeloid leukaemia	20	15	75.0	12	80.0	5	25.0
Chronic myeloid leukaemia	12	10	83.3	4	40.0	2	16.7
Acute lymphoblastic leukaemia	3	2	66.7	2	100.0	1	33.3

(a) Number of cancers in this column refers to the number of veterans with cancer rather than the number of cancers experienced by veterans, as is reported in other chapters of this report.

Two Gloster Meteor F.8 fighters take off from Kimpo, South Korea, 1952. AWM PO660/33/01

Ice formed along the deck of the frigate HMAS *Condamine* during winter in Korea, 1952. AWM 306776

4 Conclusions

This study followed a cohort of male veterans of the Korean War from 1982 to 1999 to investigate their cancer incidence patterns and to compare these patterns to those experienced by males of the same age in the Australian community. The analysis included comparisons by Service category (Navy, Army and RAAF) and by veterans' duration of service in Korea. In addition, analysis was extended to estimate the contribution of smoking to cancer patterns.

The data analyses were done under two population Scenarios. Scenario 1 excludes a group of veterans who have not been in contact with DVA since the Korean War and were not found on the Australian Electoral Roll. This group is included in Scenario 2.

The following conclusions can be made from the data presented in this report:

- This study found that between 1982 and 1999 there have been 3,543 cases of cancer among 15,041 veterans of the Korean War who were alive as at 1982. The main cancers diagnosed in Korean War veterans were prostate (21% of all cancers), lung (19%), colon (8%), melanoma (7%), rectum (6%) and head & neck (5%).
- Under both population Scenarios, the overall incidence of cancer experienced by male Korean War veterans between 1982 and 1999 was higher than the expected incidence based on the Australian community rates. Under population Scenario 1, veterans experienced a 23% greater incidence of all cancers than expected based on the rates for the Australian community, while the incidence was 13% more than expected under population Scenario 2.
- Under population Scenario 1, analyses indicate that male Korean War veterans developed smoking-related cancers—lung, head & neck, larynx and oesophagus cancers—at a level higher than expected in the Australian community. The expected incidence of these cancers under population Scenario 2 was less than under population Scenario 1 but significantly higher than expected based on the Australian community rates.
- Under population Scenario 1, the incidence of prostate, colon, rectum and melanoma cancers was significantly higher than expected. However, under population Scenario 2, although the observed incidence of these cancers was higher than expected, the excess was not statistically significant.
- Of the smoking-related cancers, the elevated rates among veterans compared to the Australian community could be explained by smoking alone as long as it could be accepted that smoking prevalence among veterans was particularly high. In the case of head & neck cancers, a smoking prevalence among veterans of 100% could not explain the level of elevation in this cancer, suggesting that other causes may be involved.
- When the data were classified by Service type, both Navy and Army personnel experienced a significantly higher incidence of total cancers compared to the Australian community rate, whereas those who served in the RAAF showed no significant difference.
- Veterans who served in the Army experienced a higher incidence of cancer than expected for a wider range of cancers, compared with veterans who served in the Navy or RAAF. This pattern was consistent for both population Scenarios.

- The incidence of smoking-related cancers—lung, larynx, oesophagus and head & neck cancers—that was significantly higher than expected among veterans in general, was also significantly higher among those who served in the Army. Among Army veterans under population Scenario 2, head & neck, lung and larynx cancers were also significantly different from that expected. Among Navy veterans, of the smoking-related cancers, only lung and head & neck cancers showed an incidence significantly different from the expected incidence, and this was consistent under both population Scenarios.
- Among those who served in the Navy, under both Scenarios the incidence of prostate cancer was significantly higher than the expected incidence based on the Australian community rate. Army and RAAF veterans showed no statistically significant difference in the incidence of prostate cancer.
- The observed incidence of melanoma cancer was significantly higher than expected among RAAF veterans under both population Scenarios. This was not indicated among Navy or Army veterans of the Korean War.
- The incidence of all cancers observed among Army veterans who served in the Korean War increased as the duration of service moved from the short duration category to the medium duration category. There was no further increase in cancer incidence for those in the long duration of service category. Due to small numbers of Navy veterans in the short and long duration categories and the associated small numbers of cancer incidence, it was not possible to declare any statistical association between duration of service and cancer outcome for Navy veterans.
- Over 58% of veterans who had developed cancer between 1982 and 1999 had died by 1999. Of these veteran deaths, 69% resulted from the same cancers experienced by them. Particularly notable are lung (89%), pancreas (89%), oesophagus (81%), liver (80%), brain (87%) and leukaemia (73%) cancers, which contributed greatly to the death toll of the Korean War veterans.

5 Future directions

In the light of the findings in this report, there are a number of areas that may warrant further investigation:

- Examination of the relationship between individual unit, group or ship exposures and cancer outcomes.
- Examination of the relationship between year of service in Korea and cancer risk:

  The changing pattern of the war meant that the Army troops who were engaged early in the war tended to be mobile, whereas those engaged later were more likely to be relatively static in trench-based warfare. These different experiences may have different cancer-related exposures and an analysis of the year of service may elucidate this issue.
- Examination of the cumulative effects of multiple conflict exposures (e.g. World War II—Korea—Vietnam):

  As a result of the timing of the Korean conflict, many servicemen would have been involved in World War II prior to the Korean conflict. Some of the Korean War veterans would have then continued their service onto the Vietnam conflict as well. It would be of some interest to understand if these servicemen who served in other conflicts had a cancer risk that was any different from their peers who did not serve in other conflicts.
- Examination of other environmental and personal risk factors and their impact on cancer risk:

  The risk factors for cancer are many and varied. The identification of cancers related to smoking in this study seems to account only for a proportion of the excess risk. An examination of the available evidence for other risk factors (environmental and personal) may explain the risk associated with other cancers.
- Examination of the histological pattern of cancers to identify any differences that may have occurred as a result of Korean conflict exposures:

  While this report has examined cancer site specific patterns, little work has been done to understand whether cancers within veterans have different histological patterns, and if they do why this might be. A study extending the work here would have the potential to answer this question.
- An examination and integration of results from the Korean War Veterans Health Survey and those from this study.

  The Korean War Veterans Health Survey has the potential to identify a range of risk factors for cancer that may be recombined with the results from this study. This may allow for some understanding of the post-conflict risk factors and their relationship to cancer risk. One of these factors might be the prevalence rate of smoking in veterans over time.

Appendixes

Appendix A: Calculation of estimated cancer rates for varying levels of smoking prevalence

The method used to estimate cancer rates for hypothetical levels of smoking prevalence uses aetiological fractions, or estimates of attributable risk of cancer due to smoking, and smoking prevalence estimates for the Australian population for the study period (1982–99). Smoking prevalence estimates were calculated by Ridolfo & Stevenson (2001), using a method proposed by Peto et al. (1992), and subsequently used in the Australian Burden of Disease Study (Mathers et al. 1999). These estimates of smoking prevalence take into account past exposure to tobacco rather than current exposure, and reflect the disease burden from the commencement of smoking.

Estimated cancer rates were calculated by separately deriving rates attributable to smoking and rates not attributable to smoking. The total rate was then calculated by weighting the rate attributable to smoking according to the hypothetical smoking prevalence in the population.

The formula is therefore:

$DR_h = SR*h + NR$

where DR_h = derived cancer rate, assuming the hypothetical prevalence h applies

SR = cancer rate due to smoking

NR = cancer rate not due to smoking

h = the hypothetical smoking prevalence

To calculate the smoking rate, SR, it was necessary to first estimate the aetiological fraction, or attributable proportion of the cancer due to smoking. The formula for calculating the aetiological fraction, F is:

$F = P*(RR-1)/(P*(RR-1)+1)$

where P is the actual smoking prevalence

RR is the ratio of the incidence rate of the cancer among those exposed to smoking to the incidence rate of those not exposed, or the relative risk of the cancer due to smoking.

The cancer rate due to smoking, SR, was then calculated using the formula:

$SR = R*F/P$

where R is the actual cancer rate

The cancer rate not due to smoking is:

$NR = R*(1-F)$

Appendix B: Membership of the Study Consultative Committee

Chair

Major General J P Stevens AO
Repatriation Commissioner

Members

Commander K M Barnett
Australian Veterans and Defence Services Council

Rear Admiral I M Crawford AO
Regular Defence Force Welfare Association

Wing Commander R C Cresswell DFC
RAAF Association

Mr S Gellatly
Korea and South East Asia Forces Association of Australia

Mr D Gibson PSM
Central Army Records Office, Department of Defence

Mr N Goldspink MBE
Returned & Services League of Australia Limited

Dr J Henderson
Korea War Veterans Association, NSW Inc

Mr W Hindson MC MG
Australian Federation of Totally and Permanently Incapacitated Ex-Servicemen and Women

Major General J C Hughes AO DSO MC
RAR Association

Professor P Kincaid-Smith AC CBE
Chair, Study Scientific Advisory Committee

Mr G A H Lang
Association of Queensland Korean Veterans Inc

Mr J Manley OAM
Naval Association of Australia

Colonel A M McDonald
Korean Veterans Association of Australia Inc

Mr I Street
Korean Veterans Tasmania

Ms P Stevenson (from April 2003)
Acting Branch Head, Defence Links, Department of Veterans' Affairs

Mrs H Parry (to April 2003)
Branch Head, Defence Links, Department of Veterans' Affairs

Appendix C: Membership of the Study Scientific Advisory Committee

Chair

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Emeritus Professor, University of Melbourne, Melbourne, Vic

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Korean Veterans Association of Australia Inc

Appendix D: Study protocol

Cancer incidence of male Veterans of the Korean War, 1982–99

Study protocol

Purpose

To investigate the incidence of cancer for male veterans of the Korean War, compare their rates to those of the overall male population of Australia, and identify statistically significant risks for the veterans. These comparisons will be restricted to the period 1982-99 because complete data on cancer incidence in Australia are only available from 1982. The comparisons will include analyses by Service category.

Information from this study will be used to assist the Department of Veterans' Affairs (DVA) in policy and programs for veterans' health care.

Organisations

DVA has contracted the Australian Institute of Health and Welfare (AIHW) to undertake this study. DVA will supply the AIHW with an identified cohort of Korean veterans. The AIHW will match the cohort with the National Cancer Statistics Clearing House (NCSCH) which contains identified cancer incidence data for the years 1982-1998, except for South Australia where records for the same period do not include name. The NCSCH is housed at the AIHW under the supervision of the Australasian Association of Cancer Registries (AACR). The South Australian Cancer Registry will match the cohort with the South Australian cancer database.

Officers

The AIHW has nominated Mr John Harding as the Study Director, Dr Paul Jelfs as the Study Advisor, and Mr Phil Trickett, Dr Chris Stevenson, Dr Indrani Pieris-Caldwell and Ms Kate Leeds as study project officers. Each of the AIHW officers is bound by the confidentiality provisions of the AIHW Act (1987) and has signed an undertaking to that effect.

DVA has nominated Dr Keith Horsley as the Project Manager of the DVA project team.

Ethics Committee Review

Approvals are required from:

I. The DVA Scientific Advisory Committee and DVA Ethics Committee.

II. All state and territory Cancer Registries.

III. The AIHW Ethics Committee.

Copies of approvals from the DVA Ethics Committee and AIHW Ethics Committee are attached and followed approval of this protocol by the Korean War Veterans Cancer Incidence Study Scientific Advisory Committee and Korean War Veterans Cancer Incidence Study Consultative Committee.

Study constraints

The main constraint of the study relates to the disclosure of identified information. No identified information will be passed on by the AIHW to third parties, including the Department of Veterans' Affairs, for any purpose. Aggregated results only will be published in the study report.

Study implementation

The study will comprise seven main components

I. Study management and advice;

II. Cohort preparation;

III. Data matching;

IV. Analysis of data;

V. Independent checking of analysis calculations;

VI. Reporting;

VII. Preparation of an article for a journal.

Specific AIHW responsibilities

AIHW will be responsible for:

I. Jointly managing the project to an agreed timetable.

II. Obtaining approval of the state and territory Cancer Registries and the AIHW Ethics Committee.

III. Data linkage with the National Cancer Statistics Clearing House.

IV. Calculation of community norms.

V. Calculation of the incidence of cancer in Korean War veterans.

VI. Preparation of the cancer incidence components of a joint DVA-AIHW report on cancer incidence and mortality in Korean War veterans.

VII. Preparation of a joint media release and distribution of the releases to the AIHW media contact list.

VIII. Professional editing and printing of the report and putting a copy on the AIHW web site.

IX. Working with the DVA Senior Medical Adviser to prepare an article for a recognised journal.

Specific DVA responsibilities

DVA will be responsible for:

I. Jointly managing the project to an agreed timetable.

II. Convening meetings of both the Scientific Advisory Committee and the Study Consultative Committee.

III. Obtaining approval by the DVA Ethics Committee.

IV. Provision of the Korean War veterans' Nominal Roll to AIHW to enable linkage with the National Cancer Statistics Clearing House.

V. Providing advice as required to AIHW on veterans' issues.

VI. Arranging refereeing of the draft report by the Scientific Advisory Committee and the Study Consultative Committee.

VII. Producing the report cover.

VIII. Arranging for Ministerial approval of release of the report.

IX. Putting a copy of the report on the DVA web-site.

X. Distribution of the report to stakeholders in the veterans community.

XI. Submission of an article to a recognised journal.

Methodology for calculation of cancer incidence among veterans and comparisons with Australian community

Record linkage

AIHW will match the nominal Korean War veterans' Nominal Roll of 17,900 male veterans to the National Cancer Statistics Clearing House to identify cases of cancer among veterans since 1982. The National Cancer Statistics Clearing House database is maintained by AIHW and contains records of all cases of cancer registered in Australia since 1982. The South Australian Cancer Registry will match the cohort with the South Australian cancer database as named records for South Australia are not provided to the National Clearing House.

All personal descriptive information such as full name, date of birth and date of death (if applicable) will be used to identify matches. The matching strategy will allow for variations in dates, misspelled names, and transposed names and dates. The criteria set for accepting a match will be established so that the specificity will be high. Clerical reviews of non-exact matches will be guided by a set of pre-established rules.

The study report will tabulate the numbers of cases of all types of cancer found in Korean War veterans in the period 1982 to 1999. AIHW will consult with the Scientific Advisory Committee on which of the cancers among male Korean War veterans will then be tested for statistical significance in comparisons with the Australian community experience. In particular, decisions may be needed on types of cancer involving very small numbers, as to whether to aggregate cancer codes for the analysis.

Comparisons of cancer incidence among Korean War veterans with the expected incidence assuming Australian community rates

Once all cases of cancer among veterans since 1982 have been identified, comparisons will then be made with the expected number of cases had the veterans experienced the cancer incidence rates of the general Australian community. The expected number of cases of each cancer being studied will be calculated for each year by applying the age-specific incidence rates for each cancer to the numbers of living Korean veterans in each age-group in that year.

In summary, the steps involved in these comparisons are:

- calculate age-specific incidence rates for the Australian population for each cancer being studied, for each year from 1982 to 1999.
- derive a population of living Korean War veterans by age for each year 1982 to 1999, from the Nominal Roll of Korean War veterans.
- for each year 1982 to 1999 calculate the expected number of cases of the cancer being studied had veterans experienced the cancer incidence rates of the general Australian

community. This is done by multiplying the corresponding age-specific incidence rates for the Australian population by the veteran population of that year.

- the expected number of cases of the cancer being studied among veterans can then be compared with the actual number of cases obtained from linking the veteran roll to the National Cancer Statistics Clearing House database and South Australian cancer registry database.

An illustration of the method used to compare the number of cases of a cancer with the expected number of cases in 1982 is provided in Table D1. Only dummy numbers, not real numbers, are used for this illustration.

Table D1. Comparison of incidence of cancer x between male Korean veterans and the total Australian male population, 1982

Age-group	Living Korean veteran population 1982	New cases of cancer x per 100,000 population, Australia, 1982	Expected cases of cancer x among Korean veterans, 1982	Actual cases of cancer x among Korean veterans, 1982
45–49	1,000	17.0	0.2	
50–54	2,000	29.0	0.6	
55–59	8,000	40.0	3.2	
60–64	4,000	67.0	2.7	
65–69	1,000	86.0	0.9	
70–74	500	107.0	0.5	
75 and over	100	97.0	0.1	
Total			8.2	15

Note: This table does not include real numbers. Dummy numbers are included for demonstration purposes.

In Table D1 there are 15 new cases of cancer x in 1982 which were identified by matching the living Korean veteran population in 1982 to the National Cancer Statistics Clearing House database. An expected number of cases of 8.2 in the 4th column is obtained by summing the expected number of cases for each age-group. The expected number of cases at each age group is derived by multiplying the number of living Korean veterans in that age-group by the rate of new cases among the total Australian population in the corresponding age-group.

The process illustrated in Table D1 will then be repeated for each year through to 1999. The number of living Korean veterans by age-group for each year will be derived from the date of birth of each veteran on the nominal roll and from information on the veterans who have died each year from 1982 to 1999. Hence the living veteran population in 1983 will be the living veteran population in 1982 minus deaths that occurred during 1982.

By summing the number of cases of cancer among Korean veterans and the expected number of cases for all years from 1982 to 1999, comparisons can then be made between the actual number of cases of a cancer and the expected number of cases for the entire period 1982 to 1999.

It is expected that the results of annual comparisons between the actual number of cancers and the expected number will vary considerably from year to year, due to random fluctuations caused by the small number of cases of many cancers which occur in any one year. It is therefore expected that comparisons will only be made for the entire period 1982–1999.

Analysis and independent checking

To ensure that all analyses of the data are correct, AIHW will:

- Write a chapter on methodology for the report so that methodology processes are transparent to AIHW and DVA staff, the Study Consultative Committee, referees and any external consultant engaged to check the validity of calculations;
- Have internal cross checking of:
  - data linkage programming
  - data linkage rules
  - incidence statistics of veterans
  - community norms calculated;
- Develop data linkage rules in consultation with DVA;
- Engage a consultant external to the Institute and agreed by DVA to check the calculations of incidence statistics and community norms.

Reporting

A joint AIHW-DVA report on the study will be produced for publication by AIHW as a printed publication and electronically on the Internet. DVA will contribute chapters on mortality and to the mortality aspects of the executive summary, methodology section, reference list, and other relevant parts of the report.

This report will be widely circulated to the veteran community after approval by DVA and the SAC.

The publication target is October 2003, with submission of a journal article in December 2003.

Retention of records

It is anticipated that the study will be repeated at some time in the future, and that this may occur in many years time. A study in the early 1980s of Australian Defence Force workers exposed to atomic testing is currently being considered for repeating, nearly 20 years later. Hence it is planned that records will be retained indefinitely by AIHW until it is agreed by the AIHW and DVA Ethics Committees that they should be destroyed. No repeat of the study will be undertaken without the approval of state and territory cancer registries and the DVA and AIHW Ethics Committees.

Appendix E: Project staff

Staff—Australian Institute of Health and Welfare

Project Directors	Dr Paul Jelfs
	Mr John Harding
Project Manager	Mr Phil Trickett
Project Officer	Dr Indrani Pieris-Caldwell
Other officers	Mr Robert van der Hoek
(Special tasks)	Ms Cathy Hotstone
	Ms Amanda Nobbs

Staff—Department of Veterans' Affairs

Dr Keith Horsley	Director of Research Studies
Dr Eileen Wilson	Epidemiologist
Dr Warren Harrex	Consultant
Mr Denis Murphy	Project Administrator

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