MONASH University

Final Report
Australian Firefighters' Health Study

MONASH
Centre for Occupational
and Environmental Health

School of Public Health & Preventive Medicine

Faculty of Medicine, Nursing and Health Sciences

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1. Summary

Background

In 2011, Monash was commissioned by the Australasian Fire and Emergency Service Authorities Council (AFAC) to carry out a national retrospective study of firefighters' mortality and cancer incidence known as the Australian Firefighters' Health Study. This study was prompted, in part, by the results of several overseas studies which had identified excesses of several types of cancers in firefighters. The aims of the study were to examine mortality and cancer among firefighters and investigate different subgroups, based on type of employment, duration of firefighting service, era of first employment/service, serving before/including or only after 1985, by the number of incidents attended and whether an individual was identified as having been a trainer.

Ethics approval for the study was granted by the Human Research Ethics Committees of Monash University, the State and Territory Cancer Registries, the Australian Institute for Health and Welfare (AIHW) and the National Coronial Information Service.

This study had an Advisory Committee whose membership was drawn from AFAC, fire agencies, trade unions and volunteer firefighter associations. The Advisory Committee provided support for, and information to, the researchers and a Technical Reference Group provided technical guidance to the researchers on the conduct of the study and on the draft report.

The agencies that contributed records of career full-time and part-time paid and/or volunteer firefighters to the study were: Australian Capital Territory Fire and Rescue, Air Services Australia, Country Fire Authority Victoria, Department of Fire and Emergency Services Western Australia, Fire and Rescue New South Wales, Metropolitan Fire and Emergency Services Board Victoria, New South Wales Rural Fire Service, Northern Territory Fire and Rescue Service, and Queensland Fire and Emergency Services.

Methods

Participating fire agencies supplied records of individual firefighters including their job histories. The start dates of the personnel records which were provided varied with agency, ranging from 1976 to 2003. Incident records were also supplied by most agencies which were attached to individual firefighters using their personnel number. The incident data also had varying start dates between 1990 and 2011. The supplied records were loaded into a secure database and checked for quality and completeness. Individuals were followed up from the date of first employment or volunteer record, or from when they joined the agency,

or the date from which the human resources agency data was complete, which ever was the later. Firefighters were grouped into tertiles duration of service and of all incidents, all fires, and number of structural, landscape and vehicle fires attended.

Each firefighter was assigned to one of the following three analysis groups: career full-time, part-time paid or volunteer firefighters. Analyses were carried out separately for these three groups because of the differing criteria to become a firefighter, differing workload, occupational histories and other possible lifestyle differences. The considerable differences in number of incidents attended and in the cancer and mortality findings between these groups showed that this was an appropriate and necessary grouping. Separate analyses were performed for male and female firefighters within these groups.

Separate analyses by agency or state were not carried out as in most cases the numbers would have been too small.

Results

To obtain mortality and cancer outcomes, the cohort was linked to the National Death Index and the Australian Cancer Database both held by the AIHW. Among men, there were 5,713 deaths and 8,750 incident cancers matched to cohort members, of which 780 deaths and 1,208 cancers were among the 17,394 career full-time firefighters, 286 deaths and 485 cancers were among the 12,663 part-time paid firefighters and 4,647 deaths and 7,057 cancers were among the 163,159 volunteer firefighters. For women, there were 536 deaths and 1,055 incident cancers, of which three deaths and eight cancers were among the 641 career full-time firefighters, seven deaths and 20 cancers were among the 1,041 part-time paid firefighters and 526 deaths and 1,027 cancers were among the 37,973 volunteer firefighters.

Australian population data were used to calculate the expected numbers of deaths and cancers for each firefighter group based on its age distribution. When compared internally, within the firefighters' analysis group for duration and incidents attended, the analyses were adjusted for age and calendar year.

There are many analyses in this report and it is important to look at the overall patterns of results, rather than focus on a single isolated result when interpreting the findings.

Overall Mortality

The overall risk of mortality was significantly decreased and almost all major causes of death were significantly reduced for male paid firefighters and for male and female volunteer firefighters. This is likely to be a result of a strong healthy worker effect and the likely lower smoking rates among firefighters compared with the Australian population. This is a common finding in such studies, whereby working populations tend to be healthier than the population from which they are drawn and this effect may be more pronounced in paid firefighters who need to meet strict fitness standards at the time of recruitment.

There was no evidence of an increase in cardiovascular or respiratory mortality for firefighters compared to the Australian population or of cardiovascular mortality from internal analyses examining risk by duration of service or number of incidents attended.

The cancer mortality risk for paid firefighters was comparatively higher than the risk for other major causes of death although still reduced compared to that of the Australian population.

Male Career Full-time Firefighters

For male career full-time firefighters compared to the Australian population, overall cancer incidence was significantly raised for the group as a whole and for those who had worked for longer than 20 years. There was no trend of overall cancer incidence increasing with duration of service when longer serving firefighters were compared to those who had served for less than 10 years, in internal analyses. There was a trend of increasing overall cancer incidence with increasing attendance at vehicle fires. The internal analyses by duration and incidents have been adjusted for age findings are unlikely to be age-related effects.

There was a statistically significant increase in prostate cancer incidence for career full-time firefighters overall, and particularly for those employed for more than 20 years. There was a significant trend with employment duration and the number of incidents attended and some significantly increased risks for higher tertiles of incidents attended.

The risk of melanoma was significantly increased for career full-time firefighters, and for both of the employment duration groups who were employed for more than 10 years. It was not related to duration of service or number or type of incidents attended in internal analyses however. Melanoma was significantly increased for all eras of first employment (pre-1970, 1970-1994, 1995 and later). When compared to state rates (melanoma varies widely throughout the country), the risk of melanoma was significantly increased for the whole group of career full-time firefighters and for those from New South Wales, Victoria and Western Australia.

Compared to the Australian population, kidney cancer was elevated for those who had been employed for 10-20 years and was significantly higher for those career full-time firefighters who worked more than 20 years compared to those who worked between three months and 10 years, and there was a positive trend with employment duration. This last finding is based on only one case in the comparison group, so it needs to be treated with caution. There were no significant elevations or trends for incident categories in respect of kidney cancer.

Lympho-haematopoetic (LH) cancer occurred at the same rate as the Australian population for the career full-time firefighters as a group but was significantly elevated for those who had worked for more than 10 years, when compared to those who had worked for less than 10 years. There was a consistent increase in LH cancer with duration of service found in internal analyses among all paid male firefighters but the trend was only statistically significant for career full-time firefighters. There were no significant elevations or trends for incident categories.

When compared to the Australian population, male breast cancer was elevated but did not reach statistical significance, it was however, statistically significantly increased among those employed for more than 20 years.

There were more cases of testicular cancer in career full-time firefighters than expected, but the numbers were small and the finding was not statistically significant. Risk was not related to duration of service or incidents attended, but the subgroups were very small.

When compared to the Australian population, stomach cancer was not increased but it was significantly raised for those firefighters who worked before 1985 but not for those employed after this date. There was no relationship with employment duration or number or type of incidents attended in internal analyses.

Compared to the Australian population, mesothelioma was statistically significantly increased for those male career full-time firefighters who had been employed for less than 10 years, but not for those in longer employment duration groups, but these analyses were based on small numbers.

Lung cancer incidence was not increased compared to the Australian population, nor did it increase with employment duration in external or internal analyses, nor with number or type of incidents attended. Definitive conclusions about the work-relatedness of lung cancer are difficult to draw in the absence of individual smoking data.

When compared to the Australian population, suicide rates were statistically significantly reduced for career full-time firefighters overall, but were elevated for those firefighters whose employment was complete before 1985 but not for those still employed after 1985. In

internal analyses, the risk of suicide was significantly reduced for the post-1985 group compared to the pre-1985 group.

Attendance at fires was associated with an increased risk of death from circulatory causes when compared to those who had attended fewest fires but the association was not statistically significant for the highest attendance group.

There was no evidence of an increased risk of overall mortality or cancer incidence among career full-time firefighters who were trainers, but the numbers were small.

Male Part-time Paid Firefighters

For male part-time paid firefighters, cancer incidence, specifically prostate cancer and melanoma incidence, were significantly raised compared to the Australian population. The prostate cancer risk was significantly associated with more than 10 years of employment both in internal and external analyses and there was a significant trend with duration but not number of incidents in internal analyses.

Melanoma risk was significantly associated with more than 20 years of employment when compared to the Australian population. When compared to state rates, melanoma risk was increased nationally and for firefighters from NSW. There was no significant trend for melanoma with duration or incidents in internal analyses.

Cancer of the digestive organs was similar to population rates for part-time paid firefighters overall but was significantly raised for firefighters with more than 20 years employment compared to those with less than 10 years employment, with a significant trend. There was however, no relationship with number or type of incidents attended.

Compared to the Australian population, brain and thyroid cancer were not significantly raised for part-time paid firefighters as a whole, but were significantly raised for those first employed before 1970 but not with other eras of first employment.

Male Volunteer Firefighters

Male volunteer firefighters did not have an overall increased risk of cancer compared to the Australian population and there was no trend of overall cancer increasing with duration of service in internal analyses, but there was a trend of increased cancer risk with the number or type of incidents attended.

Male volunteer firefighters had a significantly increased risk of prostate cancer compared to the Australian population and this was mainly associated with firefighters who had served for more than 10 years in external analyses and more than 20 years in internal analyses. The

internal analyses showed a statistically significant trend for increasing prostate cancer risk with duration of service but not with tertile of incidents.

Testicular cancer was not increased for male volunteer firefighters overall compared to the Australian population but was significantly increased for those volunteers who have attended fires compared to those who had not attended fires. It was also significantly increased for those volunteers who served for more than 20 years when compared to volunteer firefighters who served for less than 10 years (with a significant trend) and raised but not significantly so when the 20 years+ group were compared to the Australian population. There were also significantly elevated risks for some incident tertiles but there was no trend of increasing risk with increasing number or type of incidents.

Kidney cancer was not elevated when compared to the Australian population or when examined internally by service duration but there were some significant trends of increased risk with the number of incidents attended, although no individual incident tertile was significantly elevated.

Compared to the Australian population, cancer of the lip was significantly raised for volunteers who had served for more than 20 years and for those who first served before 1970. Internal analyses did not show an association with duration or number or type of incidents attended.

Melanoma risk did not appear to be related to volunteering as a firefighter with no increased risk compared to the Australian population, and no increased risk with internal analysis based on duration or number and type of incidents.

There was no increase in digestive cancers compared to the Australian population, although there were some significant trends when examined in relation to number and type of incidents, but no incident tertile was significantly elevated.

Lung cancer risk was significantly reduced when compared to the Australian population and did not show an increasing trend with duration or number or type of incidents attended. This reduction is likely to be related to the probable lower smoking rate among male volunteer firefighters.

Male volunteer firefighters had a significantly increased risk of dying in a fire, which was most likely related to two major bush fire events in the past but the mortality data does not identify whether or not the deaths were in the line of duty. Increasing duration of service was related to a significantly decreased risk of a traumatic death but increasing attendance at structural and car fires showed a significant positive trend although were no risks higher than for those who had not attended incidents.

For volunteer firefighters who attended incidents, increasing numbers of incidents appeared to be associated with trends of increases in overall deaths, of cancer incidence, of death from cancer and from circulatory disease but the mortality of the group as a whole was still significantly less than that of the Australian population.

Female Firefighters

For female career full-time firefighters there were too few deaths or cancer cases for meaningful analyses. The limited data suggested that their risks were not higher than that of the comparable members of the Australian population. For female part-time paid firefighters there were also too few deaths for meaningful analyses but there was no observed overall increased risk. For part-time paid female firefighters, there was a statistically significant increase in brain cancer, which was based on only three cases.

Female volunteer firefighters had an increased risk of accidental death compared to the Australian population for those who commenced after 1994, but it is not known whether this increase was associated with service as a firefighter. There was no association between number of incidents attended and increased mortality from accidents.

Overall cancer incidence for female volunteers was similar to that of the Australian female population but there were statistically significantly more melanomas, particularly for firefighters recruited after 1994 but the excess did not appear related to service duration or number or type of incidents in internal analyses.

There was a borderline significant result for increased colorectal cancers for those women who first volunteered after 1994. There were statistically significantly increased risks of colorectal cancer for those who had attended the most structural fires, and of female reproductive cancers for those who had attended the most landscape fires but there were no significant trends by incident or duration of service.

Other Matters

There was no evidence in male firefighters of an increase in bladder cancer, multiple myeloma or leukaemia, which were all cancers of prior interest based on previous studies. There was some evidence for an increase in digestive system cancers. However, there was limited statistical power to investigate most of the rarer types of cancers such as mesothelioma. In women, there was no evidence of an increase in cervical cancer, thyroid cancer or breast cancer but numbers were limited for paid female firefighters.

Mesothelioma has a long latent period of 30-40 years, so occupationally-related cases may not have had time to arise in this fairly recent cohort.

The majority of the cohort were still serving firefighters and were young or middle aged so the numbers of deaths and cancers were relatively small. The small numbers in the cohort limited the ability to investigate the mortality and cancer incidence of paid female firefighters.

There was uncertainty in many of the risk estimates and they should be interpreted cautiously. Further follow up is recommended in five years when there will have been more cancer and death events, which will increase as the cohort ages. These events will increase the statistical power of the study and so provide more precision on the risk of causes of death and types of cancer. This is the first study to investigate the cancer and mortality of a cohort of volunteer firefighters. There is little previous evidence about these outcomes for female firefighters.

Most volunteer firefighters attend many fewer incidents than career full-time firefighters or part-time paid firefighters, but there was a wide range of number of incidents attended. The tertiles of incident attended for career firefighters display larger absolute differences between tertiles than those for volunteer firefighters. It is more likely therefore that tertiles of incident attendance would be more capable of showing a dose effect relationship for career firefighters than would the tertiles for volunteer firefighters. As a result, the following reanalysis of the volunteer cancer incidence and mortality data is proposed:

a) Remove volunteers with no recorded incidents from the data and present internal and external analyses based only on volunteers with recorded incidents.
b) Carry out the internal incidence analyses with the volunteer firefighters divided into groups so that the death and mortality of those with the highest number of recorded incidents can be investigated. Suitable cut points might be those in the highest decile of incidents or the cut points used in the career firefighter analyses.

2. Background to the Study

In 2008, Monash University researchers were commissioned by the Australasian Fire and Emergency Service Authorities Council (AFAC) to carry out a Phase 1 study to assess the feasibility of a national study of firefighters' mortality and cancer outcomes. All AFAC member organisations involved in firefighting were invited to participate in the Phase 1 study.

After review of the data held by the participating agencies and consideration of the scientific aspects of a study, a national retrospective cohort study of Australian firefighters was considered feasible. At the conclusion of the Phase 1 study, AFAC was presented with recommendations regarding possible study designs, the findings achievable from each design and associated resources required.

In 2011, Monash was commissioned by AFAC to carry out a national study of firefighters' mortality and cancer incidence known as the Australian Firefighters' Health Study.

3. Previous findings of mortality and cancer incidence in firefighters

The scientific literature indicates that the overall mortality rate in employed firefighters is usually lower than that of the general population, but this is probably explained by the healthy worker effect.[1, 2] This effect is, at least in part, a result of the selection of fit and healthy people to become firefighters. The healthy worker effect is less likely to operate in respect of cancer incidence, cancers usually occur in later life, probably after retirement. A meta-analysis indicated that there was no evidence of a healthy worker effect in respect of published firefighter cohort cancer incidence studies however. [2]

The literature is briefly summarised here and is discussed in more detail with the relevant outcome in Section9.1 for cancer incidence and in Section 9.2 for mortality.

There is evidence that firefighting is associated with an increased risk of some cancers.[3] Several studies have shown an increased risk of the following cancers: testicular cancer, prostate cancer, non-Hodgkin lymphoma and multiple myeloma.[1, 2]

There is also some previous evidence that firefighting may be associated with the following cancers: leukaemia, malignant melanoma, male breast cancer, mesothelioma and cancers of the buccal cavity/pharynx, stomach, colon, rectum, skin, brain and bladder.[1-7]

During the course of their work, firefighters can routinely encounter a wide range of hazards. At a fire scene, firefighters are potentially exposed to various mixtures of particulates, toxic gases and fumes and many oxidation and pyrolysis products, including many known or possible carcinogens.[8-13]

Exposure by inhalation may not be the only possible route of entry to the body. Work on “smoke diving” in simulators by firefighters using Breathing Apparatus (BA), showed that exposure to polycyclic aromatic hydrocarbons (PAHs) through dermal routes could be significant.[14]

There is little evidence that there is a strong association between firefighting and death from cardiovascular disease.[15] A meta-analysis showed no increase in ischaemic heart disease among firefighters.[2] Smoking is a significant risk factor, and such data are seldom available for cohort studies. There is, some evidence from US studies that there is an increase in cardiac mortality associated with firefighting particularly close to an alarm or turnout.[16-18]

Previous studies have concentrated on cohorts of male full-time firefighters, there has been work published on female firefighters [4, 7] but none was identified for volunteer firefighters.

4. Study Aims and Objectives

The specific aims of the study were, where sufficient numbers permitted, to:

- Investigate differences in the overall death rate and rates for specific causes of death in Australian firefighters, divided into career full-time, part-time employed and volunteer firefighters, when compared to those of the Australian population. The outcomes of primary interest are deaths from cancer, cardiovascular disease, non-malignant respiratory diseases and traumatic injury.
- Examine differences in the overall cancer rate and rates of specific cancer types in Australian firefighters, divided into career full-time, part-time employed and volunteer firefighters, compared to the rates of the Australian population. The cancers of primary interest for men are: brain and central nervous system malignancies, melanoma, testicular cancer, prostate cancer, bladder cancer, non-Hodgkin lymphoma, multiple myeloma, leukaemia, cancers of the buccal cavity and pharynx, stomach, colon, rectum, mesothelioma and breast cancer and for women: cervical cancer, thyroid cancer and breast cancer.
- Compare the mortality and cancer incidence for subgroups within the cohort: by state for melanoma, ever a trainer versus not known to be a trainer, by duration of employment/service, by era of first employment/service, by the types and numbers of incidents attended and cut point in time (whether only employed before the introduction of diesel fire appliances).
- Consider investigating other health outcomes for which paid and volunteer firefighters may be at increased risk.

5. Study Design

This study was a retrospective cohort study, involving a cohort that was assembled from past and present employee and volunteer human resources (HR) and incident records, provided by the participating agencies or the shared services used by agencies.

Firefighters across Australia were included from Air Services Australia and from all State fire agencies except Tasmania and South Australia. Those employed by Defence, private contractors and companies and other State agencies were not included.

Agencies contributing records of career full-time firefighters to the study were:

- Australian Capital Territory Fire and Rescue (ACTFR)
- Air Services Australia (ASA)
- Country Fire Authority Victoria (CFA)
- Department of Fire and Emergency Services Western Australia (DFESWA)
- Fire and Rescue New South Wales (FRNSW)
- Metropolitan Fire and Emergency Services Board Victoria (MFB)
- Northern Territory Fire and Rescue Service (NTFRS)
- Queensland Fire and Emergency Services (QFES)

Agencies contributing records of part-time paid firefighters to the study were:

- FRNSW
- NTFRS
- QFES

Agencies contributing records of volunteer firefighters to the study were:

- CFA
- DFESWA
- New South Wales Rural Fire Service (NSWRFS)
- NTFRS
- QFES.

6. Ethics Committee Approvals

Monash University was granted approval from the Monash University Human Research Ethics Committee for a waiver of individual consent to access required personal information for eligible firefighters.[19] A waiver of individual consent can be approved by an Ethics Committee where requiring the gaining of individual consent would likely result in flaws in the conduct of the study and where the public interest outweighed any infringement of privacy. This would have been the case for this study, where it would not have been possible to track down all of the firefighters who have left an agency, for many of whom there would be no current address. In addition, those who had died could not consent and their exclusion would have biased the data set.

The participating agencies each provided a letter of approval to the Ethics Committee authorising the release of personal identifying information and occupational history data and incident attendance records (where available) to Monash University for the purposes of the study.

Ethics committee approval was also granted by Human Research Ethics Committees (HREC) for each of the Australian State and Territory Cancer Registries and the Australian Institute of Health and Welfare (AIHW) HREC. The AIHW is the custodian of the National Death Index (NDI) and the Australian Cancer Database (ACD), which were used to identify cases of cancer and causes of death in the study. In addition, approval was provided by State Cancer Registry data custodians and Chief Health Officers, where required.

After receipt of all necessary Cancer Registry ethics committee approvals, additional approval for data linkage was granted by the AIHW. In respect of the deaths that had been subject to coronial enquiry, approval was also granted by the National Coronial Information Service (NCIS) of the Victorian Department of Justice. Additional Coroner approvals were obtained for Western Australian and Victorian Coroner's cases.

7. Methods

7.1 Study Advisory Committee

This study had an Advisory Committee whose membership was drawn from AFAC, fire agencies, trade unions and volunteer firefighter associations. In order to provide the necessary support to the researchers the Advisory Committee met six times during the course of the study.

In addition, six-monthly bulletins were released to keep the Advisory Committee informed of the study's progress. These were also published on the study website: http://www.coeh.monash.org/ausfireftr.html.

Below are the contacts from organisations who assisted with the study and/or their representatives that who attended Advisory Committee meetings:

ACTFR	Conrad Barr, Greg Harmey
AFAC	Naomi Brown, Stuart Ellis, Judy Gouldbourn
ASA	Charles Barnard, Andrew McKay, Juli Poole, Chris Quinn, Jayne Stetto
CFA	Jeff Green, Peter Langridge, Lex De Man
CFA Volunteers	Toddy Small
DFESWA	Leah Parlour, Karen Roberts, Rachael Robertson
FBEU	Claire Pullen (Fire Brigade Employees Union)
FRNSW	Alison Donohoe, Darren Husdell, Brendan Mott, Megan Smith, Mark Reilly, Luke Unsworth
MFB	Melissa Battisti, Martin Braid, Phil McInerney, Andrew McKay, Tiffany Simpson
NSWRFS	Derrick Oliver, Daniel Moroney
NSWRFSA	Ken Middleton (NSW Rural Fire Service Association)
NTFRS	Mick Ayer, Bruce Byatt, David Pettit
QFES	Iain Mackenzie, Mark Roche, Marie Daniec, Rob Walker, Ricky May, Wayne Weston
RAAF	Paul Crawford, Robert Paterson, Chris Taylor
UFUA	Brendan Angwin, Mick Farrell, Casey Lee, Joanne Watson, Peter Marshall (United Firefighters Union of Australia)
UVNT	Erina Early, Terry Trewin (United Voice NT Branch)
VFBV	Andrew Ford (Volunteer Fire Brigades Victoria)

7.2 Technical Reference Group

In order to provide technical support to the researchers, a Technical Reference Group (TRG) was established. The group provided guidance to the researchers on the conduct of the study and evaluated and commented on the proposed analytical methodology. TRG members were not all able to meet as a group but were sent copies of bulletins, the protocol and the statistical analysis plan for comments and suggestions and a draft of the final report.

The TRG members were:
Robert D Daniels and previously Travis Kubale (Centers for Disease Control and Prevention, USA)
Alex Forrest (United Fire Fighters of Winnipeg, Canada, International Association of Firefighters)
Tee Guidotti (Fulbright Visiting Research Professor, Institute for Science, Society, and Policy, University of Ottawa, Canada)
Fabienne Reisen (Bushfire CRC and CSIRO Marine & Atmospheric Research, Australia)

7.3 Cohort eligibility

The cohort included current and former firefighters who have ever attended fires to undertake firefighting tasks, including prescribed burning, as part of their employment or volunteer membership with the participating agencies for this study. This included career full-time, part-time paid and volunteer firefighters.

In order to be included in the cohort, participants had to have a name and birth date provided by the agencies and to have served within the cohort follow up period. Cohort start and end dates varied between the agencies and these are detailed in Section 7.7 of this report.

The cohort excluded international exchange firefighters, Community Fire Unit members, cadet and junior volunteers, and agency employees or volunteers who had never taken part in firefighting activities, such as those who only did administrative or brigade support activities.

Some records provided were for apparently very young individuals whose dates of birth were checked with the relevant agency, but could not be revised. A small number of individuals were excluded from the analyses because, based on birth date and initial start date, they were apparently under 10 years of age when they started in the cohort, and it was not possible to determine which date was correct.

Some cohort members were excluded from the internal analyses because of missing or incomplete incident data, details can be found in Section 7.11.3.

7.4 Data extraction and quality assurance

Each agency supplied Monash University with records assembled onto a password protected spreadsheet sent via secure file transfer services or via password encrypted read only medium sent by post or secure courier.

For the MFB, Monash researchers captured data at the MFB from an obsolete electronic system and from hard copy records to augment the agency-supplied data from the most recent personnel database. All records relating to individuals who had worked for the MFB in or after 1980 were included.

The AIHW require several personal identifiers, such as full name and date of birth, in order to link the individuals in the cohort with records held in the registries. The data items requested from the agencies are listed in Appendix 1.

The data from the agencies and the AIHW, were uploaded into a secure SQL Server database at Monash and comprehensive data quality checking procedures were applied. More details of the data handling and checking procedures are provided in Appendix 2.

7.5 Job history and site information

Agencies were asked to identify in their data which jobs were career full-time, part-time paid or volunteer positions. Each agency was sent a list of unique job titles extracted from their HR data and asked to identify the jobs which involved turning out to fight fires. This was to ensure that employees who had *only* ever held managerial, administrative or technical jobs or were emergency service workers but not firefighters, were not included in the cohort. All individuals who had *ever* held a firefighting role, however, were included in the cohort.

Volunteer agencies were asked to identify which volunteer designations would indicate a person likely to have turned out to fight fires. This was to ensure that members who, for example, held primarily administrative or support roles were not included in the analyses.

In addition, agencies were asked to identify the firefighter trainer jobs in which trainers carried out hot fire or fire compartment behaviour training. Where necessary, agencies were also asked to identify the training sites so that these could be used to identify such trainers. One agency provided the names of individual trainers. Some agencies were not able to identify trainers in their data set. In some cases, this was because training was done by a small proportion of all individuals with the same job title. In addition, training may be done by many firefighters for a short period, i.e. it was not a sustained role. This was particularly the noted for some of the volunteer organisations.

These job characterisation tasks were either done at the agency or over the telephone with one of the researchers who then provided the agency contact with an annotated list for checking and revision where necessary.

All agencies were asked to provide an initial start date for each employee or volunteer in addition to the job history. For agencies where job history was not complete historically, the first job recorded was assumed back to the initial start date. Similar assumptions were made for other employees or volunteers from agencies where job history commenced later than initial start date.

ACTFR and NTFRS were only able to provide the last job recorded, whilst ASA job history data were only complete from 2003 onwards, job history data for the MFB were only complete from 1999 onwards. For QFES, Monash researchers were able to augment the agency-supplied data by extracting missing job histories from the previous Queensland Firefighter Cancer Study.[20] In general, data for the volunteer agencies were not as detailed and more likely to have missing time periods.

7.6 Exposure assessment

7.6.1 Metrics used in this study

If there is an increased risk of mortality and cancer incidence associated with increasing exposure then changes in exposure over the years may have modified the risk. A variety of possible risk factors were discussed with the Advisory Committee and with agency representatives and exposure was assessed in a number of ways.

1. Duration of employment/voluntary service in the firefighting agency. Person-years in the cohort were allocated to >3months but <10 years, 10-20 years, >20 years of service and the risk associated with the three groups examined. The period included time as a trainee but not as a cadet/junior in the volunteer service.
2. By era of first employment/voluntary service. Person-years in the cohort were allocated to three eras: pre-1970, 1970-1994, 1995+ and the risk associated with the three groups examined to identify differences with the era of employment. The cut points were chosen to divide the person-years into approximate tertiles.
3. Risk by cut point in time; whether or not only employed in or before 1985, that is before introduction of diesel fire appliances by most agencies[1].

[1] ACTFR has had diesel appliances since the 1970s

4. Risk was compared for those known to have been a hot fire trainer compared to that of the rest of cohort not identified as having been a trainer. It was not possible to identify everyone who may have been a trainer during the periods of missing job history, so the comparison group for the trainer analyses in the internal analyses were those firefighters who were not identified as having been a trainer.
5. Metrics were derived from the incident data provided by each agency so that firefighters were grouped by total number of incidents attended, by total fires attended and separately by structural, landscape and vehicle fires attended.

7.6.2 Incident data

Incident data refer to computerised information collected in relation to the events to which firefighters are dispatched. These may include emergency fire, rescue or hazardous materials events or non-emergency events such as false alarms. All but one participating agency maintain a computerised database containing incident information linked to individual attending firefighters.

Most agencies contribute incident data to the Australian Incident Reporting System (AIRS) which applies nationally agreed data standards to the systematic collection, recording and reporting of information about emergencies attended by fire services. There is a minimum core set of data recorded by these contributing agencies which is collected and aggregated nationally by AFAC. The structure, definitions and integrity of the core data collection is standardised across agencies. AIRS came into effect nationally in 1997, with most agencies contributing records by 1999. The records include some information about the types of incidents attended, the types and quantities of known hazardous materials at those incidents, and about fatalities at those incidents. Where attending firefighters were identified, their role at the incident and their use or non-use of BA is seldom consistently recorded.

Monash sought incident data from all contributing agencies requesting the data items listed in Appendix 1. Figure 1 shows the distribution of the number of incidents attended by individual firefighters in the analyses.

Each person in the cohort has been identified as either, career full-time or part-time paid or volunteer firefighter and all the incidents recorded for them have been included in these analyses. A number of cohort members have paid jobs with an agency and may also be volunteers with the same agency, but sometimes the incident data do not identify whether the incident was attached to their paid or voluntary roles. This study was examining the effect of exposure on the individual, so all incidents were counted for a person regardless of whether they were experienced as an employee or as a volunteer.

The incidents attributed to individuals in the cohort were identified and grouped into the sets and subsets based on the AIRS incident coding subdivisions from information provided by AFAC. The incidents were grouped as follows: all incidents (including false alarms), all fires (a subset of all incidents within AIRS coding subdivisions 10 to 19) and all landscape fires (AIRS code subdivisions 16 and 17), all structural fires (AIRS code subdivisions 11 to 14) and all vehicle fires (AIRS code subdivision 15). The last three groups are subsets of all fires.

Figure 1 Distribution of the number of incidents attended by individual firefighters by analysis group on a log scale

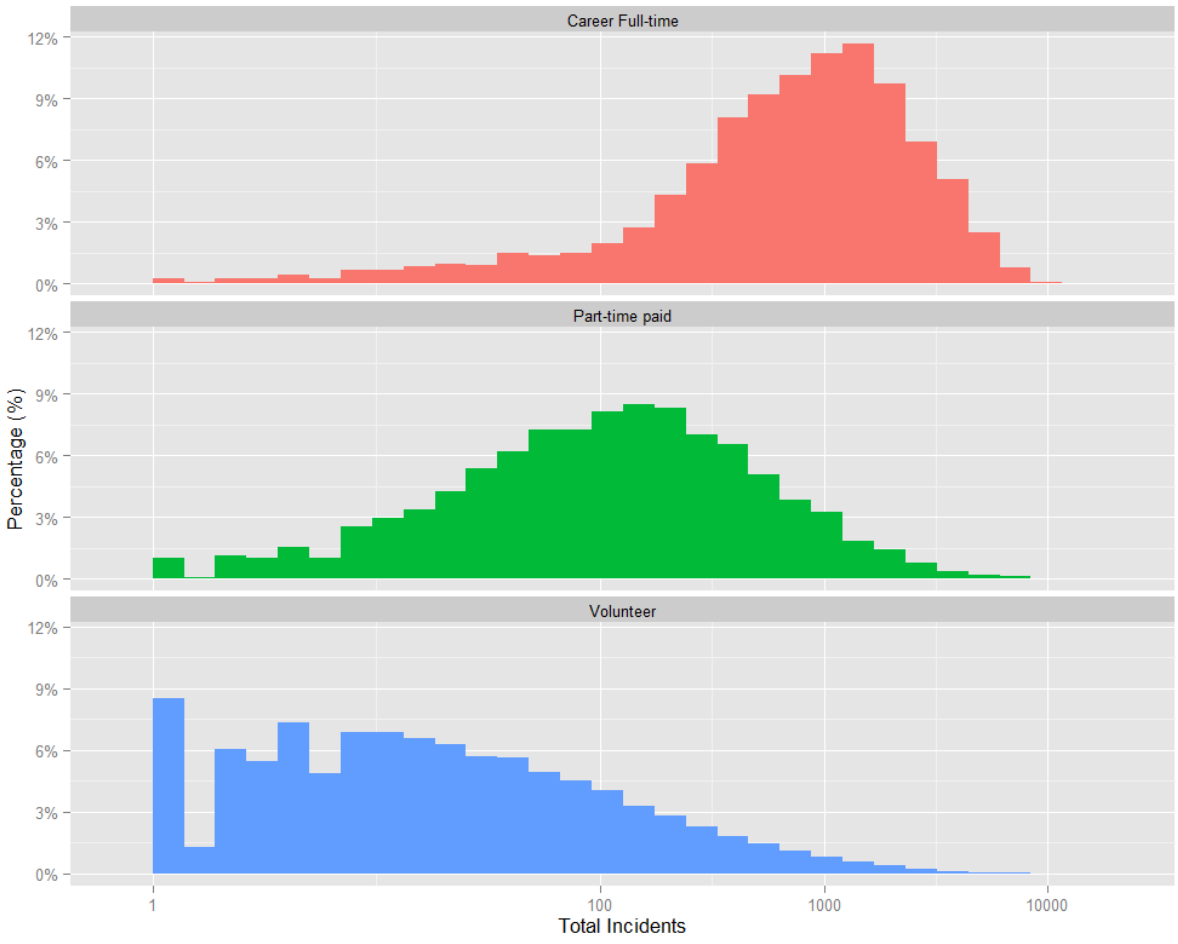


Figure 1 shows that most career full-time firefighters had more recorded incidents than part-time firefighters and the volunteer firefighters had even fewer incidents recorded. The mean (arithmetic average) cumulative value for recorded incidents was more than 1,230 for career full-time firefighters, 291 for part-time firefighters and 71 for volunteer firefighters. The

distributions were skewed however, and the median[2] numbers of incidents recorded were 820, 112 and 5 respectively. Figure 1 also shows that for each of the three analysis groups, there were a small number of firefighters who have attended many more incidents, the maximum values were over 10,000.

For career full-time firefighters 47% of incidents recorded were fires, 17% of all incidents were structural fires, 15% were landscape fires and 6% were vehicle fires. For part-time paid firefighters 78% of incidents attended were fires, 21% of all incidents were structural fires, 33% were landscape fires and 8% were vehicle fires. For volunteer firefighters 53% of incidents attended were fires, 13% of incidents were structural fires, 27% were landscape fires and 6% vehicle fires. Part-time paid firefighters were therefore more likely to be attending an actual fire when they are called out than career full-time or volunteer firefighters.

The incident analysis was restricted to those employees and volunteers who were in service after the commencement date of incident data collection for that agency. For employees and volunteers who started their service before the period when incident data collection commenced, the mean number of incidents per year, (for the years incident data were complete and available) were allocated to the years for which data were not available back to the initial start date for each individual.

Paid and volunteer firefighters whose service terminated before the commencement of incident data for that agency, could not be included in the incident analysis as it was not possible to estimate the number of incidents that the individuals had experienced.

Paid firefighters who were in service after the commencement date of the incident data for the relevant agency, but who had no recorded incidents, were excluded as this was likely to result from reporting error. Volunteer firefighters who were in service and did not have any recorded incidents were, however, included in the analyses on the advice of agencies who considered that many volunteers may not have attended incidents.

7.7 Cohort and incident data start and end dates

For the analysis, each cohort member was followed in terms of person-years and mortality and cancer incidence from a cohort start date. The cohort start date for each cohort member was 01/01/1980 for the death analysis, and 01/01/1982 for the cancer analysis, or the date of first employment/voluntary service at a participating agency, or the date from which HR agency records were deemed complete whichever was the later date (Table 1).

[2] Half the group attended more and half less than this number.

The cohort start date was the date where a cohort member commenced to contribute person-years to the analysis.

Agencies have different start dates for follow up, depending on the date at which it was thought that their HR records represented a complete set of all employees or volunteers. Some agencies had separate HR databases, one for employees and one for volunteers, with different dates of when the records were thought to be complete.

Any cancers and/or deaths found in the NDI or ACD which occurred after each individual's cohort start date were included in the analyses.

The cohort end date was 30/11/2011 for mortality and 31/12/2010 for cancer incidence, see Section 7.9. A cohort member ceased to contribute person-years after their death, when this was identified from the NDI. However they could stay at risk of another cancer after the first cancer was diagnosed. Population cancer incidence and mortality reference data for the cohort follow up period were also obtained, so that comparison age and sex specific population death and cancer incidence rates could be calculated.

Table 1: Dates by agency from which Agency data were defined as being complete

Agency	Personnel data complete from	Incident data for individuals complete from
ACTFR	01/01/1976	-
ASA	02/06/2003	01/01/2003
CFA career	01/01/1998	01/01/1998
CFA volunteer	01/01/1998	01/01/1998
DFESWA career	01/01/1985	01/01/2000
DFESWA volunteer	01/01/2000	01/01/2000
FRNSW	01/01/1994	01/01/2000
MFB	01/01/1980	01/01/1990
NSWRFS	01/01/2000	01/0/1/2001
NTFRS career	16/03/1993	01/01/2000
NTFRS volunteer	01/01/2000	01/01/2000
QFES career	01/07/1995	01/01/2000
QFES volunteer	01/01/2003	01/01/2011

7.8 Completeness of the data provided

7.8.1 Cohort data

The completeness and quality of the data provided varied by agency. Most agencies had one or more HR systems over time. Historically, when new HR systems were set up, often only current employees at that time were transferred across. That is, the HR records were not retained for individuals who had left, perhaps because they had died, resigned or retired. The possible consequential ascertainment bias is discussed in Section 9.7.1.

For some agencies, there was no active systematic follow up of volunteer firefighters, so those who had left or died may have been recorded as current members.

7.8.2 Incident data

The amount of incident data and the date from which records were thought to be complete varied with each agency, see Table 1 and Appendix 4. For each agency, the first year where there appeared to be a complete set of incident data was counted so that yearly averages could be applied retrospectively (where necessary) to each individual based on their initial start date at the agency.

In all cases, the completeness of the data depends on how thoroughly a duty commander completed an AIRS record of the incident and if he or she listed all firefighters in attendance. According to agencies, the completeness of the AIRS data has typically improved over the years since its introduction.

The ACTFR could not supply incident data that could be attributed to individual firefighters, and the incident data from the ASA were not directly comparable to that collected by other agencies so the cohort members from these agencies could not be included in the incident analyses.

The vast majority (>97%) of career and part-time paid firefighters had incidents recorded, except for QFES where 32% of firefighters and 56% of auxiliaries (part-time paid) had no incidents recorded. This is likely to be a problem with reporting and so paid cohort members with zero incidents were not included in the analyses using incident data.

For volunteer firefighters, QFES incident data were only complete from 2011 onwards and therefore was outside the follow up period for this study and could not be used. One third of the NSWRFS and two thirds of DFESWA volunteer firefighters had no incidents recorded, but the agencies verified that this was feasible and therefore they were included as a zero incident group. There were 42,439 (~30%) volunteer firefighters with zero incidents recorded. Nearly all CFA volunteers (>99%) however, had one or more incidents recorded.

7.9 Data linkage

The cohort data sent to the AIHW for linkage included: surname, given name(s) and previous name (where known), sex, date of birth and date of last contact.

Data were sent from Monash to the AIHW using a secure file transfer service. Linkage results were sent back to Monash using the AIHW secure file transfer service.

7.9.1 National Death Index

At the time of linkage in 2013, the NDI was nationally complete from 01/01/1980 until 30/11/2011 for cause of death coding. The NDI had collected deaths until mid-2013 but the cause of death was not coded at the time of the match so these individuals could not be included in the analyses presented here.

The NDI used a probabilistic linkage program to identify likely and possible matches with existing records of the underlying cause of death and score each match with a weight as to the probability of it being a true match. The possible matches were supplied to the Monash researchers for a clerical review and were independently reviewed by two researchers and disagreements examined by a third independent reviewer before a final decision was made as to which records were to be accepted as true matches.

7.9.2 Australian Cancer Database

The ACD was nationally complete from 01/01/1982 to 31/12/2010, except for the ACT and NSW, which were only complete until the end of 2009. Cancers diagnosed after this period were not included in the linkage.

The ACD uses a probabilistic matching program to identify possible matches with existing cancer incidence records. Each possible match was scored and the probability of false positives and false negatives was assessed by sampling the cohort and clerically examining the matches. The AIHW provided Monash with a list of cases that were scored as highly certain matches with cohort members i.e. they had a low probability of being an incorrect match or false positive.

For privacy reasons the AIHW was not able to release identified individuals for the clerical review to be carried out at Monash University. However, the AIHW carried out a clerical review of all career full-time and part-time paid firefighters. They also reviewed all volunteer firefighters where the birth date was uncertain or where the possible linkages had a moderate matching score. Those cancer cases identified by the clerical review as good quality matches were returned to Monash.

After the linkage the AIHW returned a de-identified list of cancer cases to Monash.

7.9.3 Quality control measures for death and cancer linkage

The data from the AIHW was also validated in the following ways:

- Death notifications which had been provided by any of the agencies were checked against all possible death matches to identify whether all deaths had been ascertained.
- NDI cancer deaths were compared to the ACD cancer incidence matches to ensure that all cancer deaths had also been registered as incident cancers. Any cancer deaths that were not recorded as incident cancers in the linkage were added to the list of cancers to ensure maximum ascertainment of cancer incidence. Overall 138 cancers were added, six among career full-time firefighters, four among part-time paid firefighters and 128 among volunteers.

7.10 Classification of causes of death and cancer

The International Classification of Diseases (ICD) coding system has been used in this study to report causes of death and cancer incidence, which enables comparisons with other studies.

The underlying cause of death for death notifications was coded by the Australian Bureau of Statistics (ABS) according to ICD-9 [21] for records up to the end of 1996, and according to ICD-10 [22] for records from 1997 onwards. Together with the introduction of the ICD-10, the ABS implemented the Automated Coding System (ACS) in 1997 for processing deaths. The ACS provides more consistent coding practices and has enabled more efficient production of statistics for multiple causes of death.

Applicable ICD-9 codes and ICD-10 codes were grouped in similar broad categories such as 'All Malignancies' or 'All Injury and Trauma' which includes all external causes (Table 2). All deaths were counted in the 'All Death Causes Combined' category and every death was assigned to a broad death category classification, including an 'Other' classification which captures all deaths that were not assigned to one of the major groups.

The ACD coded all cancer incidence records according to ICD-10, based on ICD-O-3 histology, primary site and behaviour codes. Cases were then grouped to broad cancer categories.(3) Where the numbers of cancers of a particular type were very low, they were amalgamated into the 'All Other Causes' category.

Non-melanotic skin cancers, i.e. basal cell carcinomas and squamous cell carcinomas, are not collected by Australian cancer registries so could not be examined in this study (ICD-10 C44).

Where a cancer had spread, only the site of the original primary cancer was included in the results. However, if a person was diagnosed with more than one primary cancer then all of these cancers were included in the analyses. The population data include all primary cancers and do not include secondary tumours spreading from the primary site.

Table 2: Cause of death classification in ICD-9 and ICD-10 used in this study

Cause of Death	ICD-9 codes (1983-1996)	ICD-10 codes (since 1997)
All Malignancies	**140 - 208, 238.4, 238.6, 238.7, 273.3, 273.8, 273.9**	**C00 - C97, D45 - D46, D47.1, D47.3**
All Nervous System	**320-359**	**G00 - G99**
All Circulatory	**390 - 459**	**I00 - I99**
Hypertensive Diseases	401 - 405	I10 - I15
Ischaemic Heart Disease	410 - 414	I20 - I25
Cerebrovascular	430 - 438	I60-I69
All Respiratory	**460 - 519**	**J00 - J99**
COPD	490, 491, 492, 496	J40 - J44
All Digestive	**520 - 579**	**K00 - K93**
Diseases of the Liver	570 - 573	K70 - K77
All Injury and Trauma	**E800 - E999**	**V01 - Y98**
All Accidents	E800 - E929	V01 - X59, Y85 - Y86
Fire	E890 - E899,E924	X00 - X19
Suicide	E950 - E959	X60 - X84
All Other Causes*		
Dementia and Alzheimers*	2900, 2901, 2902, 2904,2908, 2909, 3310	F00 - F03, G30
Diabetes	250	E10 - E14
All Causes of Death Combined*	**000-999**	**A00 - Z99**

* combined category across major death categories

Table 3: Cancer classification in ICD-10 used in this study*

Cancer Categories	ICD-10 codes
Lip, Oral Cavity and Pharynx	**C00 - C14**
Digestive Organs	**C15 - C25**
Oesophagus	C15
Stomach	C16
Colorectal	C18 - C21
Colon	C18
Rectum	C20
Liver	C22
Pancreas	C25
Respiratory and Intrathoracic Organs	**C30 - C38**
Larynx	C32
Lung	C33 - C34
Melanoma	**C43**
Mesothelioma	**C45**
Breast	**C50**
Female Reproductive Organs	**C51 - C58**
Cervix	C53
Male Reproductive Organs	**C60 - C63**
Prostate	C61
Testis	C62
Urinary Tract	**C64 - C68**
Kidney	C64
Bladder	C67
Brain and Other CNS	**C70 - C72**
Brain	C71
Thyroid and Other Endocrine Glands	**C73 - C75**
Thyroid	C73
Unknown Site	**C76 - C80, C26, C39**
Lymphoid, Haematopoietic, Related Tissue, Myeloproliferative & Myelodysplastic	**C81 - C96, D45 - D46, D47.1, D47.3**
Hodgkin Disease	C81
Non-Hodgkin Lymphoma	C82 - C85
Follicular non-Hodgkin Lymphoma	C82
Diffuse non-Hodgkin Lymphoma	C83.3
Multiple Myeloma	C90
Leukaemia	C91 - C95
Myelodysplastic Syndrome (MDS)*	D46
All Other Cancers ǂ	C40-42, C46-49, C69 C96 C97
All Malignancies	C00 - **C43, C45 -** C97, D45 - D46, D47.1, D47.3

* Myeloproliferative & Myelodysplastic disease are now classified with LH cancers

ǂ Includes bone and connective tissue, eye, rare LH conditions and cancer of multiple sites

7.11 Analysis and statistics

7.11.1 Groups for statistical analyses

Each cohort member was assigned to one of the three analysis groups below:

- Ever career full-time firefighter
- Ever part-time paid firefighter (includes auxiliary and retained designations) but never a career full-time firefighter
- Only ever volunteer firefighter

These are referred to as **career full-time firefighters**, **part-time paid firefighters** and **volunteer firefighters** in the results and discussion below.

All person-years and cancer or death events were similarly assigned to the same three analysis groups. If cohort members had held a position in more than one of the groups, they were assigned to one group for the purpose of the analyses. The classifications refer to the assignment within the follow up period of this study.

- People who had held both a career full-time and a part-time paid position were assigned to the ever career full-time group.
- People who had held both a paid position (full-time or part-time) AND a volunteer position were assigned to the career group (full-time or part-time as applicable).

Separate analyses were carried out for men and women in each of the three analysis groups. Separate analyses by agency or state were not carried out as this would have resulted in small numbers for most outcomes.

Data were not available from agencies on the ethnic origin of firefighters. Aboriginal and Torres Strait Islander status was not recorded by most agencies.

7.11.2 External statistical analyses

External analyses are where the mortality and cancer incidence rates of the cohort or groups within the cohort are compared to the rates of the Australian population.

The data were analysed by comparing the mortality and cancer incidence in the cohort with those expected from Australian national population data with the same age distribution. The population reference rates were taken from data published by the AIHW in five year age bands.[23]

The overall Standardised Incidence Ratio (SIR) was calculated for men and women separately for each of the three analysis groups and, where numbers permitted, SIRs were also calculated for the major cancer categories in Table 3.

The SMRs and SIRs were estimated using Stata software.[24] More details about the methodology are presented in Appendix 3.

The individuals in the three analysis groups were divided by duration of their employment/voluntary service into three duration groups, those who had served for more than three months but less than or equal to 10 years, 10 to 20 years and more than 20 years. The overall SMRs and SIRs for each duration group were calculated. The lowest duration group was set as >3 months to remove any cohort members who had only short periods of employment (e.g. 1 day) indicating possible problems with their job history.

The individuals in the three analysis groups were divided by period of first employment/voluntary service into three eras: pre-1970, 1970-1994, 1995+. The SMRs and SIRs for each era were calculated.

For male career full-time firefighters, the SMRs and SIRs were also estimated by cut point in time, by whether or not they were only employed before the end of 1985 when diesel engine appliances were introduced.

State rates of melanomas can differ because of UV exposure from sunlight, so state melanoma incidence rates were also used as a comparison.

The overall SMRs and SIRs were also calculated for those who had been identified as having been hot fire trainers

7.11.3 Internal statistical analyses

Internal analyses are where the mortality and cancer incidence of groups within the cohort are compared to a reference group which is also defined from within the cohort.

A set of internal comparisons was undertaken for male career full-time, part-time paid and volunteer firefighters, and for female volunteer firefighters. These analyses compared groups of cohort members internally against each other, rather than externally to the Australian population. This was done in an effort to reduce the impact of the Healthy Worker Effect, specifically the healthy hire effect. The Relative Mortality Ratio (RMR) for mortality and the Relative Incidence Ratio (RIR) for cancer incidence were calculated within each of these four groups of firefighters.

There were too few female paid firefighters to enable these analyses to be performed.

The RMRs and RIRs were estimated using Stata software.[24] More details about the methodology are presented in Appendix 3. The RMRs and RIRs were adjusted for age and calendar period of service. Age is a major factor predicting rates of death and cancer, so the analyses were age adjusted. In addition, they were adjusted for calendar period because death and cancer rates vary over time.

For the duration of employment analysis, the mortality and cancer incidence of the two duration groups with the longest employment/voluntary service were compared to that of the group with the shortest duration of service.

Internal analyses also compared the mortality and cancer incidence for male career full-time firefighters who only served in or before 1985 with that of those who served after 1985.

The overall RMRs and RIRs were calculated for those career full-time firefighters who had been identified as having been hot fire trainers compared to members of the cohort who had not been identified as trainers. There were too few trainers to allow analyses by duration cut point in time etc. to be performed.

For the incident internal analyses, the individual paid firefighters were grouped into tertiles, based on the cumulative total number of incidents of each type attended for each year of follow up. Those paid firefighters with no incidents recorded, but in service after the collection of incident data commenced, were not included in the analyses as these are likely to represent reporting errors. The volunteers were also grouped into tertiles but those with no incidents recorded were included on the advice of agencies.

The exposure metrics derived from the incident data were:

- Total number of incidents attended,
    - Of these, the total number of fires attended,
        - Number of structural fires attended,
        - Number of landscape fires attended,
        - Number of vehicle fires attended.

Tertiles were calculated for each of these metrics separately based on cumulative number of incidents per individual per year. For paid firefighters the higher tertiles were compared to the lowest tertile of incidents, and trend tests performed across the groups. For the volunteer firefighters the incident tertiles were compared to those with zero incidents but the trend tests were performed only across the groups with incidents.

The trend tests were conducted by assigning each exposure category (duration or incident tertile) a numeric value and using this in a Poisson regression model as a continuous variable and reporting its P-value. The investigators attempted to adjust for agency in the

internal analyses, but there were zero events for at least one agency in most categories, so the analyses dropped too many comparisons and became uninformative.

7.11.4 Tests for significance

The formal test for statistical significance is that there is less than a one in 20 probability that it was a chance finding, i.e. was due to random variation. This would be shown by 95% confidence intervals that do not include one in the lower and upper range associated with the risk ratios (SMR, SIR, RMR or RIR) (see Appendix 3) or a P-value of <0.05 on the trend tests. In this report, a P-value of <0.1 but >0.05, (less than a one in ten chance) has been interpreted as borderline significant.

7.11.5 Sensitivity analyses

The following sensitivity analyses were undertaken to investigate the effect that data limitations may have had on the death and cancer rate estimates. The overall SMRs and SIRs were recalculated based on the following conditions:

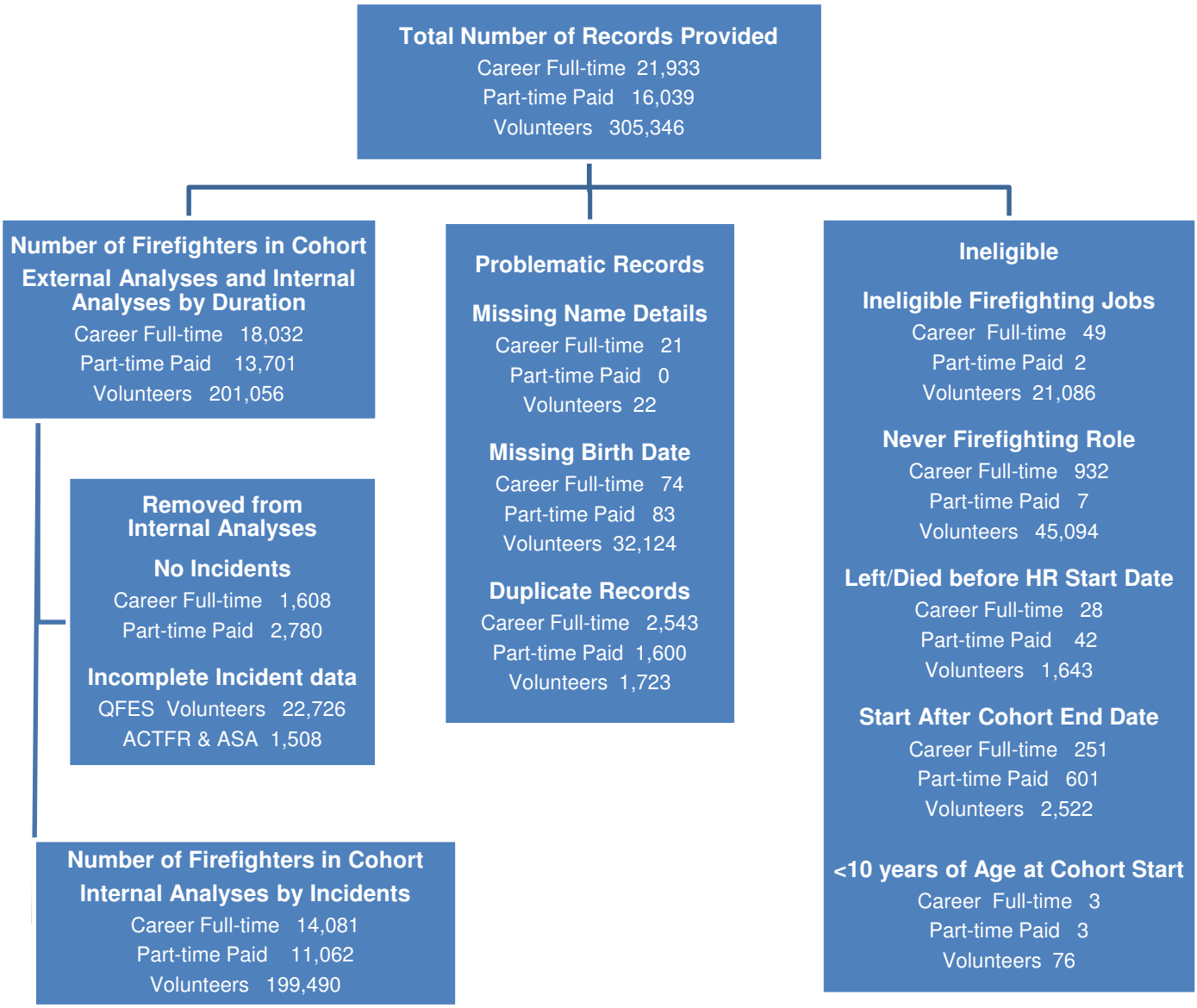
1. If the number of death notifications provided by the agencies, but not found on the NDI, were included and counted as deaths.
2. If those born before 1925 were excluded because they may have died before the NDI records began. This could have an important effect because these individuals would continue to contribute person-years to a very old age, but not be counted as a death or a cancer case.
3. Excluding those known to have worked or served for less than one year because the health status of short-term employees/volunteers may differ from that of longer term employees/volunteers.
4. Where possible to compare the findings by age to identify heterogeneity of findings for firefighters before and after retirement age e.g. <65, >65 years.
5. Existing employees may include a survivor bias in that those who are sick may leave the workforce so that only the fit, healthy and well remain employed. Examining the cancer and mortality experience of only prevalent hires would avoid this form of healthy worker effect bias, see Section 9.7.3.

8. Results

8.1 Cohort structure

The following flow chart shows the structure of the cohort, the number of records provided by agencies and the numbers of firefighters who were included in the cohort, separately for career full-time, part-time paid and volunteer firefighters. In order to be included in the cohort, participants must have a name and birth date have served in a firefighting role (Section 7.3) and served within the cohort follow up period (Section 7.7). Those only holding non-eligible positions such as international firefighters and junior members were excluded (Section 7.3). Some cohort members were excluded from the internal analyses because of missing or incomplete incident data (Section 7.11.3).

Figure 2 Cohort Structure



8.1.1 Cohort description

Table 4 presents a summary description of the individuals in the cohort including the person-years at risk, numbers of deaths and cancers and ages at various time points. There were many more men than women in each of the three analysis groups, particularly for paid firefighters.

The average age at the start of the cohort was similar for men and women in the paid firefighter groups and a little older and with a wider spread of ages for the volunteer firefighters. The average age for those who died and for those contracting cancer was older for volunteers than for paid firefighters and younger for women than men. These findings reflect the demographic makeup of the cohort. The cohort is relatively young, with an average age of under 50 at the end of follow-up, so relatively few cancers and deaths have occurred.

Table 4: Description of the cohort

	Men			Women		
	Full-time	Part-time	Volunteer	Full-time	Part-time	Volunteer
Firefighters in the cohort	17,394	12,663	163,159	641	1,041	37,973
Mean age (SD) at cohort start date	34.3 (9.4)	33.1 (10.0)	39.4 (14.9)	31.5 (7.9)	30.6 (8.8)	38.1 (14.6)
Firefighters in current employment	9,750	4,466	95,565	282	357	19,624
Sensitivity Analyses						
Born before 1925 (%)	128 (0.7)	0	1,250 (0.8)	0	0	152 (0.4)
Employed < 1 year (%)	1,253 (7.2)	1,336 (10.6)	9,776 (6.0)	115 (17.9)	194 (18.6)	3,590 (9.5)
Employed in or before 1985 (%)	549 (3.2)	0	73 (0.04)	1	0	152 (0.03)
Ever trainer (%)	1,791 (10.3)	0	87 (0.1)	41 (6.4)	0	7 (0.02)
Mortality						
Person-years of follow up	271,426	143,912	1,532,530	5,418	8,682	304,779
Mean age (SD) alive at 30/11/2011	49.4 (12.5)	44.2 (12.6)	48.3 (15.6)	39.9 (9.0)	38.8 (9.8)	45.8 (15.2)
Number of deaths from NDI linkage (%)	780 (4.5)	286 (2.3)	4,647 (2.8)	3 (0.5)	7 (0.7)	526 (1.4)
Mean age (SD) at death if deceased 30/11/2011	61.6 (13.4)	55.0 (13.9)	64.8 (15.6)	43.6 (16.1)	47.9 (12.3)	63.0 (15.3)
Cancer Incidence						
Person-years of follow up	247,469	125,582	1,325,883	4,741	7,275	253,952
Mean age (SD) at diagnosis of first cancer	57.9 (11.7)	55.4 (12.0)	61.3 (11.6)	46.1 (8.8)	43.0 (10.5)	55.5 (12.0)
Number of cancers from ACD linkage (%)	1,208 (6.9)	485 (3.8)	7,057 (4.3)	8 (1.2)	20 (1.9)	1,027 (2.7)

8.2 Mortality and cancer incidence findings for male and female firefighters compared to the Australian population

In sections 8.3 to 8.9 the mortality and cancer incidence for firefighters is compared externally to those expected based on the age and sex specific rates from the Australian population.

8.2.1 Mortality for male firefighters

Among men, there were 5,713 deaths from the NDI, matched to cohort members, of which 780 were among the 17,394 career full-time firefighters, 286 among the 12,663 part-time paid firefighters and 4,647 among the 163,159 volunteer firefighters.

The overall SMRs varied by agency from 0.26 (n=2 deaths)[3] to 0.98 (n=11) for career full-time; 0.55 (n=3) to 0.82 (n=91) for part-time paid and 0.26 (n=197) to 0.72 (n=7) for volunteer agencies. Most agencies had an overall SMR of between 0.50 and 0.70 for each of the analysis groups. The more extreme values in the range were usually associated with a smaller number of deaths so there was more uncertainty.

The overall SMR and the SMR for all seven major causes of death categories were reduced[4] in all three analysis groups, and this reduction was statistically significant[5] for six of the seven categories for career full-time firefighters (Table 5) and part-time paid firefighters (Table 6) and for all categories for male volunteer firefighters (Table 7). Volunteers had the only statistically significantly raised SMR,[6] for a death subcategory of dying in a fire (Table 7).

The SMRs for deaths from cancers were reduced for paid firefighters but less reduced than were other causes of death.

The agencies notified Monash of 3,316 deaths among male cohort members during the follow up period, and of these no acceptable match was identified on the NDI linkage for 5% (n=183). There were no notified deaths not found on the NDI among part-time paid firefighters, there were six notified deaths not found among career full-time firefighters and 177 notified deaths not found among volunteer firefighters. If these individuals had been matched the overall SMR for career full-time firefighters would have been 0.67 (95%CI 0.63 - 0.72)[7] and for volunteer firefighters 0.56 (0.54 - 0.57), which means that the exclusion of these deaths made a negligible difference to the overall SMRs.

[3] n is the number of events, in this case deaths
[4] A reduced SMR means that the firefighter group has a lower than expected death rate (SMR < 1.00).
[5] Statistically significant means that the 95% confidence intervals do not include 1.00
[6] A raised SMR means that the firefighter group has a higher than expected death rate (SMR > 1.00)
[7] All confidence intervals are 95%, i.e. there is less than a 1 in 20 probability that this is a chance finding

There was concern that volunteer records contained some very elderly volunteer firefighters, who may have died before death registries commenced and by remaining in the cohort were over estimating the expected number of deaths. All male volunteer firefighters who were born in or before 1925 (n=1,250) were removed and the SMRs recalculated as a sensitivity analysis. This resulted in 590 volunteer firefighter deaths being removed and the recalculated SMR was 0.54 (0.52 - 0.55), which again made a negligible difference to the overall SMRs.

In a further sensitivity analysis, all male firefighters with less than one year's service were removed and the SMRs recalculated. This removed 1,253 full-time, 1,336 part-time and 9,776 volunteer firefighters from the analyses, including 21, 22 and 204 firefighter deaths respectively. The overall SMR for career full-time firefighters was then calculated to be 0.66 (0.61 - 0.71), for part-time paid firefighters it was 0.62 (0.55 - 0.70) and for volunteer firefighters the SMR was 0.52 (0.51 - 0.54). Some SMRs for major causes of death increased, others decreased but the differences were very small. (Data not shown.)

Table 5: Standardised Mortality Ratios (SMR)* and 95% confidence intervals (95%CI) for male career full-time firefighter deaths to 30/11/2011 compared to the Australian population (Observed (O), Expected (E))

Cause of Death Categories	Career Full-time Firefighters (N=17,394)		
	O	E	SMR (95%CI)
All Causes of Death Combined	**780**	**1169.95**	**0.67 (0.62 - 0.72)**
All Malignancies	**329**	**407.77**	**0.81 (0.72 - 0.90)**
All Nervous System	20	30.19	0.66 (0.40 - 1.02)
All Circulatory	**209**	**327.74**	**0.64 (0.55 - 0.73)**
Hypertensive	5	5.95	0.84 (0.27 - 1.96)
Ischaemic Heart Disease	**150**	**210.57**	**0.71 (0.60 - 0.84)**
Cerebrovascular	**27**	**50.06**	**0.54 (0.36 - 0.78)**
All Respiratory	**38**	**65.60**	**0.58 (0.41 - 0.80)**
COPD	**22**	**35.79**	**0.61 (0.39 - 0.93)**
All Digestive	**30**	**49.44**	**0.61 (0.41 - 0.87)**
Diseases of the Liver	22	32.80	0.67 (0.42 - 1.02)
All Injury & Trauma	**88**	**172.05**	**0.51 (0.41 - 0.63)**
All Accidents	**35**	**91.37**	**0.38 (0.27 - 0.53)**
Fire	1	2.08	0.48 (0.01 - 2.68)
Suicide	**50**	**67.20**	**0.74 (0.55 - 0.98)**
All Other Causes	**63**	**117.14**	**0.54 (0.41 - 0.69)**
Dementia & Alzheimers	9	10.61	0.85 (0.39 - 1.61)
Diabetes	23	26.66	0.86 (0.55 - 1.29)

* Statistically significantly reduced SMR results are in **blue**

Table 6: Standardised Mortality Ratios* and 95% confidence intervals for male part-time paid firefighter deaths to 30/11/2011 compared to the Australian population

Cause of Death Categories	Part-time Paid Firefighters (N= 12,663)		
	O	E	SMR (95%CI)
All Causes of Death Combined	**286**	**439.03**	**0.65 (0.58 - 0.73)**
All Malignancies	124	148.34	0.84 (0.70 - 1.00)
All Nervous System	**4**	**12.05**	**0.33 (0.09 - 0.85)**
All Circulatory	**60**	**104.49**	**0.57 (0.44 - 0.74)**
Hypertensive	3	1.87	1.61 (0.33 - 4.69)
Ischaemic Heart Disease	**39**	**66.50**	**0.59 (0.42 - 0.80)**
Cerebrovascular	9	14.97	0.60 (0.27 - 1.14)
All Respiratory	**8**	**20.03**	**0.40 (0.17 - 0.79)**
COPD	**3**	**10.14**	**0.30 (0.06 - 0.86)**
All Digestive	**8**	**18.95**	**0.42 (0.18 - 0.83)**
Diseases of the Liver	**5**	**13.44**	**0.37 (0.12 - 0.87)**
All Injury & Trauma	**68**	**89.54**	**0.76 (0.59 - 0.96)**
All Accidents	42	46.19	0.91 (0.66 - 1.23)
Fire	2	0.90	2.22 (0.27 - 8.03)
Suicide	**22**	**36.09**	**0.61 (0.38 - 0.92)**
All Other Causes	**14**	**45.63**	**0.31 (0.17 - 0.51)**
Dementia & Alzheimers	2	2.49	0.80 (0.10 - 2.90)
Diabetes	**1**	**9.69**	**0.10 (0.00 - 0.58)**

* Statistically significantly reduced SMR results are in **blue**

Table 7: Standardised Mortality Ratios* and 95% confidence intervals for male volunteer firefighter deaths to 30/11/2011 compared to the Australian population

Cause of Death Categories	Volunteer Firefighters (N= 163,159)		
	O	E	SMR (95%CI)
All Causes of Death Combined	4647	8676.93	0.54 (0.52 - 0.55)
All Malignancies	1900	3202.94	0.59 (0.57 - 0.62)
All Nervous System	121	266.65	0.45 (0.38 - 0.54)
All Circulatory	1250	2430.98	0.51 (0.49 - 0.54)
Hypertensive	31	50.92	0.61 (0.41 - 0.86)
Ischaemic Heart Disease	718	1462.46	0.49 (0.46 - 0.53)
Cerebrovascular	189	424.74	0.44 (0.38 - 0.51)
All Respiratory	216	587.02	0.37 (0.32 - 0.42)
COPD	115	316.71	0.36 (0.30 - 0.44)
All Digestive	108	338.91	0.32 (0.26 - 0.38)
Diseases of the Liver	50	198.40	0.25 (0.19 - 0.33)
All Injury & Trauma	663	926.81	0.72 (0.66 - 0.77)
All Accidents	405	507.67	0.80 (0.72 - 0.88)
Fire	19	10.37	1.83 (1.10 - 2.86)
Suicide	204	340.71	0.60 (0.52 - 0.69)
All Other Causes	379	923.61	0.41 (0.37 - 0.45)
Dementia & Alzheimers	57	147.68	0.39 (0.29 - 0.50)
Diabetes	86	232.82	0.37 (0.30 - 0.46)

* Statistically significantly elevated SMR results are in **red**, statistically significantly reduced SMR results are in **blue**

8.2.2 Mortality for female firefighters

For women, there were 536 deaths found in the NDI linkage, of which three were among the 641 career full-time firefighters, seven among the 1,041 part-time paid firefighters and 526 among the 37,973 volunteer firefighters.

Agencies had an overall SMR for female firefighters of between 0.25 and 0.72; one agency had an SMR of 1.33 but this was based on only two deaths.

The overall SMR was reduced for all three analysis groups, and significantly so for volunteers (Table 8). The SMR for the 641 career full-time firefighters was 0.63 (0.13 - 1.85) (n=3), for the 1,041 part-time paid firefighters it was 0.95 (0.38 - 1.96) (n=7). There were too few deaths for meaningful analyses by death category for either full-time or part-time paid firefighters.

For female volunteers the SMR for most of the major cause of death categories were significantly reduced (Table 8). The only major cause of death that was not decreased was that for external causes, mainly fatal accidents. Accidental death was 30% higher than expected for female volunteer firefighters. This increase was close to being statistically significant (Table 8).

There were 550 female firefighters with death notifications from the agencies and of these no acceptable match was identified on the NDI for 3% (n=14). All the notified deaths for full-time or part-time paid firefighters were found on the NDI. If the 14 notified deaths among volunteers had been identified, the overall SMR for volunteer firefighters would have been 0.66 (0.60 - 0.72), which does not affected the findings.

As a sensitivity analysis, all 152 female volunteer firefighters who were born in or before 1925 were removed from the analysis, which excluded 61 deaths. The SMR for female volunteer firefighters after removal of these older women was 0.65 (0.59 - 0.71), which was only a very small reduction on the previous finding.

There were no deaths among female career full-time firefighters who had served for less than one year. There was one death among female part-time paid firefighters and 42 among female volunteers. For those with at least one year's service, the SMR for career full-time firefighters was 0.70 (0.15 - 2.06), for part-time paid firefighters it was 0.91 (0.33 - 1.98) and for volunteer firefighters the SMR was 0.62 (0.56 - 0.67). There was negligible change in the major death categories for volunteer firefighters. There were too few deaths among full-time and part-time paid female firefighters to make examination of death categories a meaningful reanalysis.

Table 8: Standardised Mortality Ratios* and 95% confidence intervals for female volunteer firefighter deaths to 30/11/2011 compared to the Australian population

Cause of Death Categories	Volunteer Firefighters (N= 37,973)		
	O	E	SMR (95%CI)
All Causes of Death Combined	**526**	**822.93**	**0.64 (0.59 - 0.70)**
All Malignancies	**268**	**359.13**	**0.75 (0.66 - 0.84)**
All Nervous System	**11**	**31.78**	**0.35 (0.17 - 0.62)**
All Circulatory	**100**	**184.17**	**0.54 (0.44 - 0.66)**
Hypertensive	2	6.26	0.32 (0.04 - 1.15)
Ischaemic Heart Disease	**37**	**80.85**	**0.46 (0.32 - 0.63)**
Cerebrovascular	**24**	**49.67**	**0.48 (0.31 - 0.72)**
All Respiratory	**21**	**56.05**	**0.37 (0.23 - 0.57)**
COPD	**11**	**28.70**	**0.38 (0.19 - 0.69)**
All Digestive	**15**	**29.91**	**0.50 (0.28 - 0.83)**
Diseases of the Liver	**5**	**13.75**	**0.36 (0.12 - 0.85)**
All Injury and Trauma	66	61.82	1.07 (0.83 - 1.36)
All Accidents	47	35.10	1.34 (0.98 - 1.78)
Fire	2	1.93	1.04 (0.13 - 3.74)
Suicide	14	19.05	0.73 (0.40 - 1.23)
All Other Causes	**44**	**100.08**	**0.44 (0.32 - 0.59)**
Dementia & Alzheimers	13	19.71	0.66 (0.35 - 1.13)
Diabetes	**11**	**20.96**	**0.52 (0.26 - 0.94)**

* Statistically significantly reduced SMR results are in **blue**

8.2.3 Cancer incidence for male firefighters

There were 8,750 cancers matched on the ACD, to male cohort members, of which 1,208 were among career full-time firefighters, 485 among part-time paid firefighters and 7,057 among volunteer firefighters. The overall SIR was statistically significantly elevated for career full-time firefighters (Table 9), and part-time paid firefighters (Table 10), but not for volunteers (Table 11). The SIRs for most major cancer categories were similar to that of the Australian population for paid firefighters (Table 9 and Table 10).

There were, however, statistically significantly raised SIRs for melanoma among career and part-time paid firefighters (Table 9 and Table 10). The rate of male reproductive cancer was statistically significantly raised for all three analysis groups, mainly because of the increased rate of prostate cancer, but the testicular cancer rate was also raised and was close to reaching statistical significance for career full-time firefighters (Table 9).

There were more observed colorectal cancers, mesotheliomas and male breast cancers than expected for career full-time firefighters but the increases were not statistically significant (Table 9). There were more brain cancers observed than expected for male part-time paid firefighters but again the increase was not statistically significant (Table 10).

There were significantly fewer respiratory cancers than expected for all three analysis groups of firefighters (Table 9, Table 10 and Table 11). There was a statistically significant reduction in most of the major cancer categories for male volunteer firefighters (Table 11).

All volunteers who were born in or before 1925 (n=1,248) were removed as a sensitivity analysis, removing 301 cancers, and the SIRs were then recalculated. The overall SIR for volunteer firefighters was then 0.87 (0.84 - 0.89). The difference, after removal of these older firefighters, was negligible.

All firefighters with less than one year's service were removed in another sensitivity analysis and the SIRs were recalculated. This sensitivity analysis removed 1,128 full-time, 1,403 part-time and 11,382 volunteer firefighters including 27 career full-time firefighter cancer cases, 10 part-time and 116 volunteer cancer cases. The SIR for firefighters with more than one year of service was: 1.07 (1.01 - 1.14) for career full-time firefighters, 1.11 (1.01 - 1.22) for part-time paid firefighters and 0.86 (0.84 - 0.88) for volunteer firefighters. The SIRs for some major cancer categories increased slightly, others decreased but the differences were small.

Table 9: Standardised Cancer Incidence Ratios (SIR)* and 95% confidence intervals for male career full-time firefighters to 31/12/2010 compared to the Australian population

Cancer Categories	Career Full-time Firefighters (N=17,394)		
	O	E	SIR (95%CI)
All Malignancies	**1208**	**1121.04**	**1.08 (1.02 - 1.14)**
Lip, Oral Cavity & Pharynx	55	58.12	0.95 (0.71 - 1.23)
Lip	23	20.73	1.11 (0.70 - 1.66)
Digestive Organs	230	230.08	1.00 (0.87 - 1.14)
Oesophagus	12	15.79	0.76 (0.39 - 1.33)
Stomach	24	24.54	0.98 (0.63 - 1.46)
Colorectal	157	144.65	1.09 (0.92 - 1.27)
Colon	92	81.48	1.13 (0.91 - 1.38)
Rectum	55	46.43	1.18 (0.89 - 1.54)
Liver	8	15.34	0.52 (0.23 - 1.03)
Pancreas	22	20.55	1.07 (0.67 - 1.62)
Respiratory	**100**	**122.95**	**0.81 (0.66 - 0.99)**
Larynx	11	12.74	0.86 (0.43 - 1.54)
Lung	86	106.57	0.81 (0.65 - 1.00)
Melanoma	**209**	**144.31**	**1.45 (1.26 - 1.66)**
Mesothelioma	11	8.30	1.33 (0.66 - 2.37)
Male Reproductive	**357**	**298.15**	**1.20 (1.08 - 1.33)**
Prostate	**325**	**263.93**	**1.23 (1.10 - 1.37)**
Testis	31	21.48	1.44 (0.98 - 2.05)
Urinary tract	59	64.91	0.91 (0.69 - 1.17)
Kidney	33	34.09	0.97 (0.67 - 1.36)
Bladder	23	27.14	0.85 (0.54 - 1.27)
Brain & Other CNS	17	21.89	0.78 (0.45 - 1.24)
Brain	16	20.96	0.76 (0.44 - 1.24)
Thyroid & Other Endocrine	13	12.04	1.08 (0.58 - 1.85)
Thyroid	13	11.05	1.18 (0.63 - 2.01)
Unknown Site	27	27.29	0.99 (0.65 - 1.44)
Lympho-haematopoetic	109	114.25	0.95 (0.78 - 1.15)
Hodgkin Disease	6	6.57	0.91 (0.34 - 1.99)
Non-Hodgkin Lymphoma	47	48.04	0.98 (0.72 - 1.30)
Follicular-NHL	16	12.00	1.33 (0.76 - 2.16)
Diffuse-NHL	22	22.65	0.97 (0.61 - 1.47)
Multiple Myeloma	15	13.11	1.14 (0.64 - 1.89)
Leukaemia	28	30.52	0.92 (0.61 - 1.33)
MDS	4	4.40	0.91 (0.25 - 2.33)
All Other Cancers	21	18.76	1.12 (0.69 - 1.71)
Male Breast	5	2.01	2.49 (0.81 - 5.82)

* Statistically significantly elevated SIR results are in **red**, statistically significantly reduced SIR results are in **blue**

Table 10: Standardised Incidence Ratios* and 95% confidence intervals for male part-time paid firefighters to 31/12/2010 compared to the Australian population

Cancer Categories	Part-time Paid Firefighters (N=12,663)		
	O	E	SIR (95%CI)
All Malignancies	**485**	**438.83**	**1.11 (1.01 - 1.21)**
Lip, Oral Cavity & Pharynx	21	23.57	0.89 (0.55 - 1.36)
Lip	11	8.66	1.27 (0.63 - 2.27)
Digestive Organs	85	85.68	0.99 (0.79 - 1.23)
Oesophagus	5	5.90	0.85 (0.28 - 1.98)
Stomach	9	8.73	1.03 (0.47 - 1.96)
Colorectal	57	53.74	1.06 (0.80 - 1.37)
Colon	27	29.61	0.91 (0.60 - 1.33)
Rectum	21	17.82	1.18 (0.73 - 1.80)
Liver	4	6.23	0.64 (0.17 - 1.64)
Pancreas	7	7.56	0.93 (0.37 - 1.91)
Respiratory	**17**	**41.67**	**0.41 (0.24 - 0.65)**
Larynx	1	4.42	0.23 (0.01 - 1.26)
Lung	**15**	**35.73**	**0.42 (0.23 - 0.69)**
Melanoma	**89**	**62.37**	**1.43 (1.15 - 1.76)**
Mesothelioma	4	2.91	1.38 (0.37 - 3.52)
Male Reproductive	**167**	**118.78**	**1.41 (1.20 - 1.64)**
Prostate	**153**	**101.01**	**1.51 (1.28 - 1.77)**
Testis	12	12.87	0.93 (0.48 - 1.63)
Urinary tract	25	24.07	1.04 (0.67 - 1.53)
Kidney	19	14.13	1.34 (0.81 - 2.10)
Bladder	5	8.71	0.57 (0.19 - 1.34)
Brain & Other CNS	13	9.47	1.37 (0.73 - 2.35)
Brain	12	9.06	1.32 (0.68 - 2.31)
Thyroid & Other Endocrine	7	6.03	1.16 (0.47 - 2.39)
Thyroid	7	5.56	1.26 (0.51 - 2.59)
Unknown Site	6	9.31	0.64 (0.24 - 1.40)
Lympho-haematopoetic	43	47.17	0.91 (0.66 - 1.23)
Hodgkin Disease	4	3.52	1.14 (0.31 - 2.91)
Non-Hodgkin Lymphoma	19	19.93	0.95 (0.57 - 1.49)
Follicular-NHL	7	5.19	1.35 (0.54 - 2.78)
Diffuse-NHL	9	9.39	0.96 (0.44 - 1.82)
Myeloma	3	4.94	0.61 (0.13 - 1.78)
Leukaemia	15	12.40	1.21 (0.68 - 2.00)
MDS	0	1.60	-
All Other Cancers	8	7.79	1.03 (0.44 - 2.02)
Male Breast	1	0.76	1.31 (0.03 - 7.32)

* Statistically significantly elevated SIR results are in **red**, statistically significantly reduced SIR results are in **blue**

Table 11: Standardised Cancer Incidence Ratios* and 95% confidence intervals for male volunteer firefighters to 31/12/2010 compared to the Australian population

Cancer Categories	Volunteer Firefighters (N=163,159)		
	O	E	SIR (95%CI)
All Malignancies	**7057**	**8216.17**	**0.86 (0.84 - 0.88)**
Lip, Oral Cavity & Pharynx	**245**	**342.79**	**0.71 (0.63 - 0.81)**
Lip	125	108.68	1.15 (0.96 - 1.37)
Digestive Organs	**1297**	**1679.28**	**0.77 (0.73 - 0.82)**
Oesophagus	**77**	**117.63**	**0.65 (0.52 - 0.82)**
Stomach	**116**	**166.98**	**0.69 (0.57 - 0.83)**
Colorectal	**897**	**1052.62**	**0.85 (0.80 - 0.91)**
Colon	**526**	**603.91**	**0.87 (0.80 - 0.95)**
Rectum	301	334.48	0.90 (0.80 - 1.01)
Liver	**39**	**118.61**	**0.33 (0.23 - 0.45)**
Pancreas	**116**	**156.67**	**0.74 (0.61 - 0.89)**
Respiratory	**429**	**869.75**	**0.49 (0.45 - 0.54)**
Larynx	**36**	**80.74**	**0.45 (0.31 - 0.62)**
Lung	**371**	**766.31**	**0.48 (0.44 - 0.54)**
Melanoma	912	916.15	1.00 (0.93 - 1.06)
Mesothelioma	**42**	**65.17**	**0.64 (0.46 - 0.87)**
Male Reproductive	**2763**	**2564.17**	**1.08 (1.04 - 1.12)**
Prostate	**2655**	**2368.28**	**1.12 (1.08 - 1.16)**
Testis	99	107.14	0.92 (0.75 - 1.13)
Urinary tract	**334**	**461.48**	**0.72 (0.65 - 0.81)**
Kidney	**196**	**239.97**	**0.82 (0.71 - 0.94)**
Bladder	**117**	**195.23**	**0.60 (0.50 - 0.72)**
Brain & Other CNS	116	134.42	0.86 (0.71 - 1.04)
Brain	114	129.27	0.88 (0.73 - 1.06)
Thyroid & Other Endocrine	62	76.25	0.81 (0.62 - 1.04)
Thyroid	58	70.30	0.83 (0.63 - 1.07)
Unknown Site	**101**	**184.25**	**0.55 (0.45 - 0.67)**
Lympho-haematopoetic	**663**	**817.01**	**0.81 (0.75 - 0.88)**
Hodgkin Disease	33	38.66	0.85 (0.59 - 1.20)
Non-Hodgkin Lymphoma	**267**	**321.54**	**0.83 (0.73 - 0.94)**
Follicular-NHL	74	79.10	0.94 (0.73 - 1.17)
Diffuse-NHL	**126**	**153.10**	**0.82 (0.69 - 0.98)**
Myeloma	**74**	**99.13**	**0.75 (0.59 - 0.94)**
Leukaemia	194	216.52	0.90 (0.77 - 1.03)
MDS	42	51.74	0.81 (0.59 - 1.10)
All Other Cancers	93	105.47	0.88 (0.71 - 1.08)
Male Breast	12	14.46	0.83 (0.43 - 1.45)

* Statistically significantly elevated SIR results are in **red**, statistically significantly reduced SIR results are in **blue**

8.2.4 Cancer incidence for female firefighters

There were 1,055 cancers from the ACD, matched to female cohort members, of which eight were among career full-time firefighters, 20 among part-time paid firefighters and 1,027 among volunteer firefighters. The overall SIR for all cancers for career full-time firefighters was 0.82 (0.35 - 1.61), (n=8). There were too few cancers for meaningful analyses by major cancer categories so no such SIRs are reported for the career full-time firefighters.

The overall SIR for female part-time paid firefighters was somewhat elevated but did not reach statistical significance (Table 12). The SIR for the brain and nervous system category was significantly elevated based on three cases. There were elevations in SIRs for melanoma, female reproductive system and thyroid cancers and a reduced SIR for breast cancer. All four of these SIRs were based on small numbers and none were statistically significant.

The overall SIR for female volunteer firefighters was the same as that of the Australian population (Table 13). There was, however, a statistically significantly raised SIR for melanoma. Rectal and some of the lympho-haematopoetic (LH) cancer subcategories were elevated but no clear pattern emerged and none were statistically significantly raised.

All female volunteer firefighters who were born in or before 1925 were removed (n=152) from the analysis as a sensitivity analysis and the overall SIR was recalculated. This removed 22 cancers but there was negligible change to the SIRs or confidence intervals.

All firefighters with less than one year's service were removed from the analysis. This removed 100 career full-time firefighters but no cancer cases; 199 part-time paid firefighters and four cancer cases; and 4,042 volunteer firefighters and 45 cancer cases. The SIR for firefighters with more than one year of service was: career 0.91 (0.39 - 1.79); part-time paid firefighters 1.24 (0.71 - 2.01); volunteer firefighters 0.96 (0.90 - 1.03). In all three cases, the SIR fell slightly when these cancers were removed.

Table 12: Standardised Cancer Incidence Ratios* and 95% confidence intervals for female part-time paid firefighters to 31/12/2010 compared to the Australian population

Cancer Categories	Part-time Paid Firefighters (N=1041)		
	O	E	SIR (95%CI)
All Malignancies	20	14.50	1.38 (0.84 - 2.13)
Lip, Oral Cavity & Pharynx	0	0.27	-
Digestive Organs	2	1.38	1.45 (0.18 - 5.25)
Respiratory	0	0.52	-
Melanoma	5	2.38	2.10 (0.68 - 4.90)
Mesothelioma	0	0.02	-
Breast	3	5.20	0.58 (0.12 - 1.69)
Female-Reproductive	4	1.62	2.46 (0.67 - 6.30)
Urinary tract	0	0.28	-
Brain & Other CNS	**3**	**0.26**	**11.75 (2.42 - 34.35)**
Thyroid & Other Endocrine	3	1.03	2.90 (0.60 - 8.49)
Unknown Site	0	0.16	-
Lympho-haematopoetic	0	1.17	-
All Other Cancers	0	0.21	-

* Statistically significantly elevated SIR results are in **red**

Table 13: Standardised Cancer Incidence Ratios* and 95% confidence intervals for female volunteer firefighters to 31/12/2010 compared to the Australian population

Cancer Categories	Volunteer Firefighters (N=37,973)		
	O	E	SIR (95%CI)
All Malignancies	1027	1061.23	0.97 (0.91 - 1.03)
Lip, Oral Cavity & Pharynx	16	19.70	0.81 (0.46 - 1.32)
Lip	6	5.09	1.18 (0.43 - 2.56)
Digestive Organs	163	164.88	0.99 (0.84 - 1.15)
Oesophagus	4	5.39	0.74 (0.20 - 1.90)
Stomach	**4**	**11.68**	**0.34 (0.09 - 0.88)**
Colorectal	131	116.11	1.13 (0.94 - 1.34)
Colon	81	74.18	1.09 (0.87 - 1.36)
Rectum	38	28.19	1.35 (0.95 - 1.85)
Liver	**1**	**5.75**	**0.17 (0.00 - 0.97)**
Pancreas	13	16.88	0.77 (0.41 - 1.32)
Respiratory	66	73.32	0.90 (0.70 - 1.15)
Larynx	0	1.38	-
Lung	65	69.92	0.93 (0.72 - 1.18)
Melanoma	**147**	**118.07**	**1.25 (1.05 - 1.46)**
Mesothelioma	3	2.04	1.47 (0.30 - 4.29)
Breast	349	364.41	0.96 (0.86 - 1.06)
Female-Reproductive	**88**	**110.27**	**0.80 (0.64 - 0.98)**
Cervix	**12**	**22.51**	**0.53 (0.28 - 0.93)**
Urinary tract	23	29.46	0.78 (0.49 - 1.17)
Kidney	19	19.35	0.98 (0.59 - 1.53)
Bladder	**2**	**7.61**	**0.26 (0.03 - 0.95)**
Brain & Other CNS	15	14.98	1.00 (0.56 - 1.65)
Brain	13	14.12	0.92 (0.49 - 1.57)
Thyroid & Other Endocrine	41	40.98	1.00 (0.72 - 1.36)
Thyroid	39	40.04	0.97 (0.69 - 1.33)
Unknown	15	19.52	0.77 (0.43 - 1.27)
Lympho-haematopoetic	90	90.75	0.99 (0.80 - 1.22)
Hodgkin Disease	8	5.98	1.34 (0.58 - 2.63)
Non-Hodgkin Lymphoma	38	37.81	1.00 (0.71 - 1.38)
Follicular-NHL	14	11.29	1.24 (0.68 - 2.08)
Diffuse-NHL	15	15.67	0.96 (0.54 - 1.58)
Myeloma	13	10.25	1.27 (0.68 - 2.17)
Leukaemia	23	20.93	1.10 (0.70 - 1.65)
MDS	3	4.55	0.66 (0.14 - 1.93)
All Other Cancers	11	12.85	0.86 (0.43 - 1.53)

* Statistically significantly elevated SIR results are in **red**, statistically significantly reduced SIR results are in **blue**

8.3 Mortality and cancer incidence for prevalent hires

Half of the career firefighters were prevalent hires, that is the firefighters who were recruited after the start date for the relevant agency, but they accounted for only 16% of deaths and 17% of cancers (Table 14). A similarly low proportion of deaths and cancers were found among the prevalent hires for the part-time and volunteer firefighters. This low number of events prevented analyses on this basis.

Table 14: Number of cancers and deaths occurring among prevalent hires and percentage of those in the whole cohort of men and women

	Prevalent Hires			Whole cohort		
	Full-time	Part-time	Volunteer	Full-time	Part-time	Volunteer
Participants	9,933	9,510	78,234	18,035	13,704	201,132
(%)	(55)	(69)	(39)			
Deaths	127	77	1,065	783	293	5,173
(%)	(16)	(26)	(21)			
Cancers	210	112	2,096	1,216	505	8,084
(%)	(17)	(22)	(26)			
Person Years	116,756	80,792	574,689	276,844	152,594	1,837,309
(%)	(42)	(53)	(31)			

8.4 External analyses by age group

The SMRs and SIRs for firefighters were examined by age (under 65 and 65 years or over) with the individual firefighters' person-years contributed allocated across the two age groups. The death or cancer attributed to the group in which it occurred. These sensitivity analyses investigated the heterogeneity of findings by age.

For ease of reading of these results, the tables in sections 8.3 to 8.9 are in Appendix 5.

8.4.1 Mortality

For male career full-time firefighters, the SMR was higher for the older group in all the major death categories examined and most of the sub categories. In most cases, the SMRs for the younger group were statistically significantly lower than expected and for the older group the observed numbers became very similar to from those expected based on the Australian population (Table 18). The overall death rate and the death rate from respiratory causes remained statistically significantly lower for the older age group.

A similar pattern was seen for most major causes of death for male part-time paid firefighters, but the smaller numbers in many categories made some of the confidence intervals wider (Table 19).

Table 20 shows the SMRs for male volunteer firefighters by age group. The rates were remarkably consistent for the two age groups, for all the major death categories examined. For most of the sub categories both SMRs were statistically significantly reduced.

The SMRs for female firefighters were also examined by age. There were too few deaths among paid female firefighters to analyse specific causes of death by age. For female career full-time firefighters, the overall SMR for those under 65 was 0.65 (0.13 - 1.89) (n=3) and overall cancer mortality was 0.51 (0.01 - 2.82) (n=1). There were no deaths in either group for those aged over 65.

For part-time paid female firefighters the overall SMR for those under 65 was 0.96 (0.39 - 1.99) (n=7) and overall cancer mortality was 0.97 (0.2 - 2.85) (n=3).

For female volunteer firefighters, the SMR increased for the older age group for some of the major death categories examined and most of the sub categories. In most cases the SMRs for both groups were statistically significantly lower than expected (Table 21). The overall death rate was similar for the two age groups. However, there was a statistically significant increased risk of death by accident for the under 65 years age group.

8.4.2 Cancer incidence

When examined by age group, among older male career full-time firefighters, the SIR for all cancers was statistically significantly higher than expected (Table 22). The SIRs for most of the major cancer categories were higher for older male full-time and part-time paid firefighters than for younger firefighters (Table 22 and Table 23). The exceptions for career full-time firefighters were the male reproductive system (there were no testicular cancers in either of the older paid groups) and LH cancer (mainly driven by leukaemia which was lower for the older group). Mesothelioma was lower for the older male paid firefighters but this was based on very small numbers.

For all male firefighter analysis groups, the SIRs were statistically significantly raised for prostate cancer for both age groups. The SIRs were statistically significantly raised for melanoma for all groups of male paid firefighters.

Among male volunteer firefighters there was little difference between the SIRs for the two age groups. Most major category SIRs were statistically significantly reduced for both groups, including for melanoma for the 65+ group (Table 24).

The SIRs for female firefighters were also examined by age group. There were too few cancers among paid female firefighters to analyse specific cancer categories by age group. For female career full-time firefighters, the overall SIR for those under 65 was 0.83 (0.36 -

1.63) (n=8). For part-time paid firefighters the overall SIR for those under 65 was 1.39 (0.85 - 2.14) (n=20). There were no cancers in either group for women aged over 65.

For the older female volunteer firefighters, the SIRs were higher than those for the younger volunteers for some of the major cancer categories examined but there was no clear pattern (Table 25). The numbers of observed cancers were similar to those expected from population rates. Cervical cancer was significantly reduced for younger women and melanomas were significantly increased.

8.5 External analyses by duration of service

8.5.1 Mortality by duration

For male career full-time (Table 26) and part-time paid firefighters (Table 27), dividing by duration of service (>3months to <10 years, 10-20 years, >20 years) resulted in small numbers in each analysis group and most SMRs were not statistically significant. Overall death rate and death from cancer increased for career full-time firefighters with more than 20 years of service but was still significantly reduced compared to the Australian population (Table 26).

There was little evidence of a pattern for male part-time paid firefighters (Table 27).

For male volunteer firefighters, the analysis by duration showed that the SMR for all causes of death and the SMR for overall malignancies reduced with increasing years of service (Table 28). The SMRs for most cause of death categories, however, were still statistically significantly reduced compared to the Australian population (Table 28).

This was the opposite of the pattern seen among paid firefighters, but again the numbers were too small in most categories to draw firm conclusions. After 10 years of service, the overall SMR for male volunteer firefighters from Dementia/Alzheimers and diabetes fell and was significantly reduced (Table 28).

There were too few deaths among female career full-time and female part-time paid firefighters to carry out analysis by duration of service. For female volunteer firefighters, there was no evidence of a pattern by duration of service for any of the major cause of death categories (Table 29).

8.5.2 Cancer incidence by duration

For cancer incidence among male career full-time firefighters, the SIR for all malignancies increased monotonically by duration category and became statistically significant for those who had served for more than 20 years (Table 30). This was mainly related to melanoma

incidence which was significantly increased for those who had served for more than 10 years and prostate and male breast cancers which were significantly raised for those who had served for more than 20 years. Mesothelioma incidence was significantly raised for those male career full-time firefighters who had served for less than 10 years but this was based on small numbers. In career full-time firefighters, respiratory cancers, specifically lung cancer, showed a monotonic reduction with employment duration and they were significantly reduced for those who had served for more than 20 years. Kidney cancer was elevated for those who had served for more than 10 years and was close to statistical significance for those who had served for 10 to 20 years.

The overall cancer SIR for male part-time firefighters did not change with work duration but prostate cancer and melanoma SIRs were significantly raised for those groups who had served for more than 10 and 20 years respectively (Table 31). For male part-time firefighters, there were too few cases of mesothelioma to show a pattern with duration of employment.

The SIR for all malignancies among male volunteer firefighters did not change with duration of service and remained significantly lower than that of the Australian population (Table 32). The melanoma rates for volunteer firefighters were similar to those of the Australian population and did not change over duration. Prostate cancer SIRs showed a monotonic increase with service duration and were statistically significantly raised for those who had served for more than 10 years. The SIRs for testicular cancer increased with duration but none of these SIRs were statistically significant. For male volunteer firefighters the mesothelioma rate was significantly reduced for those with the longest service category. There was a monotonic increase through duration categories in the SIR for cancer of the lip, oral cavity and pharynx. The SIR for lip cancer was significantly raised for male volunteer firefighters who had served for more than 20 years. Lung cancer was significantly reduced for all volunteer firefighter duration categories.

Male breast cancer was significantly increased for those career full-time firefighters who had served for more than 20 years, this was not seen in part-time paid or volunteer firefighters but there was a non-significant elevation for those volunteer firefighters who had served for more than 20 years (Table 30, Table 31 and Table 32).

There were too few cancers among female career full-time and female part-time paid firefighters to carry out analysis by duration of service.

For female volunteer firefighters, there was no evidence of an overall trend by duration of service or a trend by length of service for most major cancer categories (Table 33). There was a statistically significant increase in melanoma for those in the shortest duration

category and the SIR fell monotonically with duration. There was also a monotonic increase with duration for cancers of the lip, oral cavity and pharynx, and for brain cancer and myeloma but none of the SIRs were statistically significant and the numbers were small.

There was a statistically significant reduction in female reproductive cancers among volunteer firefighters in the shortest duration category but no clear pattern across the duration categories. There was, however, a monotonic decrease for colorectal and multiple myeloma but again none of the SIRs were statistically significant (Table 33).

8.6 External analyses by era of first employment/service

Firefighters were grouped by era of when they were first employed or volunteered (pre-1970, 1970-1994, 1995+) and the mortality and cancer incidence of each era compared to that expected from the Australian population. This analysis examined whether there were changes in risk depending on the era of work, perhaps as a result of changes to work practices or personal protective equipment.

8.6.1 Mortality by era of first employment/service

For male career full-time firefighters, there was a monotonic reduction in the SMRs with more recent era of first employment, being associated with a bigger reduction in all-cause mortality, circulatory, respiratory and digestive causes of death than first employment in earlier years (Table 34). Where there was sufficient power, most SMRs were significantly reduced compared to the Australian population.

A similar pattern was seen for male part-time paid firefighters although the SMRs were less likely to be statistically significantly reduced which may be a result of the smaller numbers in these analyses (Table 35).

For male volunteers, most of the SMRs were significantly reduced for all eras and no patterns were discernible (Table 36).

There were too few deaths among female career full-time and female part-time paid firefighters to carry out an analysis by era.

For female volunteer firefighters there were few deaths associated with first service before 1970, probably as a result of the small numbers of female volunteer firefighters serving during that period (Table 37). There was no obvious pattern of association between mortality and era of first service for these firefighters. There was a statistically significant increase in accidental deaths for women who joined after 1994. There was a monotonic increase by era of first employment for respiratory mortality which was most strongly associated with those

who joined after 1994 but even this SIR was still significantly reduced compared to the Australian population.

8.6.2 Cancer incidence by era of first employment/service

For male career full-time (Table 38), part-time paid firefighters (Table 39) and volunteer firefighters (Table 40) the overall cancer SIR was not strongly associated with era of first employment. There was a non-statistically significant increase in the overall cancer SIR for all groups of paid firefighters (Table 38 and Table 39) and a monotonic increase for career full-time firefighters, the SIRs for all three eras were close to statistical significance but there was a monotonic decrease in SIRs with era for part-time paid firefighters (Table 39). There was no pattern for volunteer firefighters (Table 40). When the analysis groups were split into three eras, the number in each era group is smaller and so the confidence intervals increase.

For male career full-time firefighters the risk of melanoma was significantly increased for firefighters first employed in all eras (Table 38). Prostate cancer was significantly increased for those firefighters first employed before 1995. Neither of these cancers showed a relationship with era of first employment. For male career full-time firefighters, mesothelioma, thyroid cancer and non-Hodgkin lymphoma (NHL) showed some increase with era of first employment with the highest SIR being associated with those who were most recently employed but the numbers were small.

For male part-time paid firefighters there was a similar monotonic elevation by first employment era for male reproductive cancer, specifically prostate cancer for which the increase was statistically significant for all eras (Table 39). On the other hand, melanoma rates were highest for those who started employment before 1970 and this was the only group where the SIR was statistically significantly raised. For male part-time paid firefighters thyroid and brain cancers were significantly associated with being employed before 1970 but not with other periods, but the numbers were small. Lung cancer was significantly reduced for those who were first employed before 1970 but not for other eras.

For male volunteer firefighters, most SIRs were significantly reduced and there was little discernible association with era of first service (Table 40). There was a monotonic increase by era for respiratory cancer which was most strongly associated with first volunteering after 1994 but even this SIR was still significantly reduced. Firefighters, who first volunteered before 1994, were more likely to have significant elevations in prostate and lip cancer compared to the Australian population. The rate of melanoma was significantly reduced for those who first volunteered before 1970, and was similar to population rates for those who joined later between 1970 and 1994 and was significantly increased for those who first volunteered after 1994.

There were too few female career full-time firefighters (Pre-1970 n=0; 1970-1994 n=65; Post 1995 n=576) or female part-time paid firefighters (Pre-1970 n=0; 1970-1994 n=86; Post 1995 n=955) to carry out an analysis by era of first service.

There was little pattern with respect to era and cancer risk for female volunteer firefighters (Table 41). As was seen for male volunteer firefighters, there was a significant association between melanoma diagnosis and first volunteering after 1994. In addition, as for male volunteers, there was also a monotonic increase by era for the respiratory cancer SIR which was most strongly associated with female firefighters who first volunteered after 1994. There was a monotonic reduction in the female reproductive cancers with era and the SIR was statistically significantly reduced for those first employed after 1994.

8.7 External analyses of employment before and after 1985

This analysis is intended to examine whether the introduction of diesel appliances in 1985 had an effect on mortality or cancer incidence. In this analysis, the cancer and mortality rates of firefighters who ceased employment in or before 1985 and those who were employed after 1985 were separately compared to the expected rates from the Australian population. The post-1985 group includes those who were first employed before 1985 if they were also employed after 1985.

For men in the cohort, 3.1% (n=549) of career full-time firefighters, no part-time paid firefighters and 0.4% (n=73) of volunteers in this study ceased service in/before 1985.

For women in the cohort, 0.16% (n=1) of career full-time firefighters, no part-time paid firefighters and 0.03% (n=152) of volunteers served only in/before 1985.

Given the small numbers for most groups in this cohort, it was only possible to analyse the career full-time firefighters by service pre- and post-1985.

8.7.1 Mortality by employment before and after 1985

For male career full-time firefighters, the overall SMR, and SMRs for all major death categories were significantly reduced for those employed after 1985 (Table 42). For those who only served before this date, there were no significantly raised or lowered major causes of death except for cerebrovascular disease which was significantly reduced (based on small numbers), and suicide which was significantly elevated for the pre 1985-only career full-time firefighters. There were non-statistically significant elevations in COPD, digestive deaths including from liver disease, and injury and trauma for the pre-1985 group but in most cases the numbers were small.

8.7.2 Cancer incidence by employment before and after 1985

For male career full-time firefighters the overall cancer rate was raised for those who were employed after 1985, but not for those whose service was completed by the end of 1985. This was mainly as a result of significant elevation in melanoma, and male reproductive cancers (prostate and testis) in the post-1985 group (Table 43). These three cancers were also non-statistically significantly elevated for the earlier group.

The only significant elevation in the pre-1985 group was for stomach cancer for which there was a two-fold elevation; this was not seen in the post 1985 group. Lung cancer was reduced for both groups, while mesotheliomas was somewhat raised for both groups but none of the differences were statistically significant (Table 43).

8.8 Melanoma incidence compared to state rates

When melanoma rates were compared to the relevant state rates the overall risk did not greatly change, but dividing cases by states resulted in small numbers so that increases or decreases were not statistically significant.

Among male career full-time firefighters the risk was significantly elevated for the group as a whole and for NSW, Victorian and WA firefighters. For male part-time paid firefighters the risk was elevated for the group as a whole and specifically for NSW firefighters (Table 44). For male volunteers rates were elevated for all states except Queensland but none were statistically significantly raised.

There were too few female full-time or part-time paid firefighters to present analyses by state. Among female volunteer firefighters there was a small but significant increase for the group as a whole, but not for individual states (Table 45) although the rate in NSW was close to statistical significance.

8.9 Mortality and cancer incidence among trainers

There were 1,791 male career full-time firefighters and 87 male volunteers who were identified as ever having been trainers. There were likely to have been trainers among the rest of the cohort but these were not identifiable.

There were 41 female career full-time firefighters and seven female volunteers who were identified as trainers. There were no male or female part-time paid firefighters identified as trainers. There were too few female firefighter trainers to calculate SMRs or SIRs.

The overall SMR for male trainers who were career full-time firefighters was 0.27 (0.12 - 0.51) (n=9); for male volunteer firefighters it was 0.27 (0.01 - 1.48) (n=1). The overall cancer SIR for male trainers who were career full-time firefighters was 1.15 (0.83 - 1.55) (n=42); for male volunteer firefighters it was 0.62 (0.13 - 1.80) (n=3). The numbers were small, the confidence intervals were wide so these are imprecise estimates.

8.10 Internal analyses within the cohort groups

The tables discussed in this section are in Appendix 6. Where there were fewer than 9 events in a major death or cancer cateogory, the category was omitted from the analyses. There were too few career full-time (n=430) or part-time paid (n=601) female firefighters with incidents to carry out RMR or RIR analyses for service employment duration or number of incidents.

These analyses compared the lowest exposure group in terms of duration of service or number of incidents for each incident category with the remainder of the groups; and for male career full-time firefighters comparing employment before and after 1985.

The cut points for the tertiles vary with firefighter groups and with the type of incident category. The cut points are shown in Table 46.

8.10.1 Internal comparisons for mortality

There were no statistically significant increases in overall mortality or of major causes of death with increasing employment duration for full-time or part-time paid firefighters (Table 47 and Table 48). Longer serving part-time paid firefighters were significantly less likely than those who had served for shorter periods to have died and they were less likely to have died from cancer or from injury or trauma, particularly suicide and the trends of these reductions were significant. There was a monotonic increase in deaths from circulatory causes for male part-time paid firefighters, but the trend was not significant.

For male volunteer firefighters, but not for female volunteers, increasing duration of service showed a significant reduction in overall death, for deaths from cancer and from injury or trauma including suicide, and the trends were statistically significant (Table 49). For female volunteers, there was an increase in IHD (ischaemic heat disease) mortality with increasing duration of service and trend was borderline statistical significance (P=0.07) (Table 50).

Career full-time firefighters who worked after 1985 were compared to those who had completed their employment by the end of 1985 (Table 47). For all major death categories the RMRs were statistically significantly reduced except for death from cancer where it was reduced but the confidence interval included 1.

There were no significant trends of mortality with increasing number of total incidents, of all fire incidents or by types of fire attended for paid firefighters (Table 51 and Table 52).

There were non-significantly elevated RMRs for death from cancer for those career full-time firefighters who had attended more vehicle fires. Those firefighters in the middle tertile had an increased risk of death from cancer compared to those in the lowest tertile for landscape fires. The increases were not monotonic however and the highest tertile did not show an increase compared to the lowest tertile. There were higher RMRs for deaths from circulatory causes for those career full-time firefighters who had attended more fires. Those firefighters in the middle tertile had a significantly increased rate of circulatory deaths compared to those in the lowest tertile but the increase was not statistically significant for the highest group, nor for the vehicle fire incident groups (Table 51). The increase was largely driven by deaths from IHD which was raised and close to reaching statistical significance for the middle tertile for all fire incidents, compared to the group who had attended the fewest fires. There was also an increase in death rates from injury/trauma, specifically from suicide which rose monotonically with the number of vehicle fires attended, but neither the RMRs nor the trend test were statistically significant and the numbers were small.

Part-time paid firefighters in the all-fire incident group showed monotonically increasing RMRs, for combined causes of death, for deaths from cancer and from injury/trauma compared to the lowest tertile (Table 52). There were much higher risk estimates for death from cancer than for other outcomes and there was a monotonic increase with number of fires attended, more than three-fold for those in tertile 2 and more than five-fold for those in tertile 3 compared to tertile 1, the trend test was close to being statistically significant. There were more than two-fold increases in circulatory deaths in the middle tertile associated with more attendance at landscape and vehicle fires but there was no significant trend. Most incident types, however, only have a very small number of deaths among those with the fewest incidents so the RMRs were not statistically significant and had very wide confidence intervals (Table 52).

When male volunteer firefighters were divided into tertiles by number of incidents and compared to those with zero incidents, there was a statistically significant reduction in the RMRs for almost all incident groups for the combined causes of death, and for deaths from cancer and circulatory disease including IHD (Table 53). There was a monotonic increase in these RMRs with an increase in incidents. However the trend tests, performed only across the tertiles of firefighters with incidents were significantly increased for most of these categories.

Female firefighters also showed a similar monotonic increase in these three major death categories with increase in incidents attended, but the trend tests were significant only for combined causes of death and there were few significantly reduced RMRs (Table 54). There was an association between increased risk of death from cancer and number of incidents attended, specifically for all fires and landscape fires where the risk was significantly raised for those in the highest tertiles of attendance, the trend test was significant for landscape fires.

For career trainer firefighters, the overall RMR was 0.31 (0.16 - 0.6) with 9 trainer deaths and 771 deaths among those not known to be trainers.

8.10.2 Internal comparisons for cancer incidence

For male career full-time and part-time paid and volunteer firefighters, there was no trend of increasing overall cancer incidence with duration of service. Sensitivity analyses were also carried out for career full-time firefighters, by excluding all those who had served for less than one year (Table 55). These showed some differences in risk estimates as detailed below.

Prostate cancers were not significantly increased when compared to the >3 months to 10 years group but were significantly raised for the 20+ duration group when compared to the >1 year to 10 years group, both trend tests were statistically significant.

For male career full-time firefighters, the RIRs for urinary tract cancer was statistically significantly increased for all the duration categories compared to the baseline group and the trend tests were statistically significant, including after those who served between three months and 1 year were removed. Kidney cancer risk was elevated for all durations when compared to baseline, and was statistically significant for the 20+ group when compared tho those who had served for three months to one year and the trend was statistically significant. The findings were similar but not statistically significant when all firefighters serving less than 1 year were removed comparison group. There was only one case of kidney cancer in the reference group so these are somewhat uncertain findings.

Also among male career full-time firefighters, the RIRs by duration were significantly raised for LH cancers and the trend tests were statistically significant (Table 55). For NHL, the 20+ duration group was significantly increased when compared to both of the groups who had been employed for less than 10 years. The trend tests were also both significant.

For male career full-time firefighters, the RIRs for respiratory cancers, specifically lung cancer, showed no increase with employment duration. Those male career full-time firefighters who served for 10+ years had higher RIRs than the baseline group for cancers of the lip, oral cavity and pharynx, but the trend test was not significant.

The cancer rates for career full-time firefighters employed after 1985 were compared to those of firefighters employed only before 1985 (Table 55). For those employed after 1985 the RIR was significantly reduced for lung cancer. Melanomas were more common among the post-1985 group but the increase was not statistically significant.

Comparing career full-time trainer firefighters to the firefighters not known to be trainers, resulted in an RIR of 1.01 (0.77 - 1.32) (n= 57) for trainers and for non-trainers n=1151.

For male part-time paid firefighters, the RIRs for digestive cancers, specifically colorectal cancer, were statistically significantly increased for the 20+ year category compared to those who had served for less than 10 years, and the trend tests were statistically significant (Table 56). Prostate cancer was significantly raised for the 10-20 and 20+ groups also with a significant trend test. Melanoma and LH cancers showed a monotonic increase with employment duration but the trend tests were not statistically significant.

Among volunteer firefighters, the RIRs for male reproductive cancers, specifically prostate cancer and testicular cancer, and for urinary tract cancers were statistically significantly increased for the 20+ year category compared to those who had served for less than 10 years, and the trend tests were statistically significant. There was no trend with duration for melanoma (Table 57). Lung cancer rates showed a negative trend with length of service.

For female volunteer firefighters the RIR for lip, oral cavity and pharyngeal cancer showed a monotonic increase with duration but the increases and the trend test were not statistically significant (Table 58). There was a statistically significant increase in risk of female reproductive cancers for those who had served for 10 to 20 years compared to those who had served less than 10 years.

For male career full-time firefighters, the RIR for all cancers was raised for tertiles 2 and 3 of all the incident groups, and significantly raised for tertiles 2 and 3 of vehicle fire incidents attended compared to tertile 1 where the trend test was also significant (Table 59). The RIR for male reproductive cancers specifically prostate cancer was significantly raised for the groups with the highest number of incidents and there was a statistically significant trend. There was a statistically significant trend of increasing RIRs for prostate cancer with increasing incidents for all incident groups. Urinary cancers, specifically kidney cancer risks were elevated with most incident categories but there was no clear trend. LH cancers were not elevated for those with more with incidents. Those male career full-time firefighters in the highest tertile of incidents attended, had higher RIRs than those in the middle tertile for cancers of the lip, oral cavity and pharynx and respiratory cancers. In these cancer categories, the base line group, those who had been to the fewest incidents, had a higher rate of cancer than those in the middle tertile and so the trend test was not significant. This

was also the case for part-time paid firefighters and cancer of the digestive system and melanoma for some incident types.

Table 60 shows very little relationship between cancer and increasing number of incidents for part-time paid firefighters. Prostate cancer was raised but not significantly so, the trend test was not significant for any incident type.

For male and female volunteer firefighters confidence intervals for most RIRs included 1, that is, the cancer rates by number of incidents attended were not significantly different from the rates in those volunteers who had not attended fires.

For male volunteer firefighters, Table 61 shows some trends of increasing cancer risk with increasing number of incidents attended for overall cancers, digestive (colorectal) and urinary tract cancers (kidney), the firefighters in the lowest tertile were less likely to develop cancer compared to those who had not attended incidents and the trends were significant for some incident categories. There were raised rates of prostate cancer for firefighters in higher tertiles compared to those with no incidents for landscape and vehicle fires, for the highest tertile of landscape fires the risk was of borderline significance ($P<0.1$). There were significantly raised rates of testicular cancer for firefighters in higher tertiles compared to those with no incidents, however trend tests across non-zero incident categories were not significant.

For female volunteer firefighters, Table 62 shows some trends of increasing cancer risk with increasing number of incidents attended for digestive cancers, the firefighters in tertile 1 were somewhat less likely to develop cancer than those who had not attended incidents, however trend tests across non-zero incident categories were not significant. There was an increased risk of cancer for those who had attended the most vehicle fires which reached borderline significance, for lung cancer in the highest tertile of landscape fires and for urinary tract cancers in the highest tertile for structural fires; both of these risks were close to achieving statistical significance. In addition, for urinary tract cancers, the trend tests for all incident groups except vehicle fires was of borderline significance ($P<0.1$).

9. Discussion

9.1 Cohort cancer incidence

Compared to the Australian population, the incidence of cancer was elevated by about 8% for male full-time and 11% for male part-time paid firefighters and these increases were statistically significant. For career full-time firefighters this elevation was significantly associated with those who had served for more than 20 years and there is a small increase in the point SMR over the three duration groups. There is no significant trend when compared within the duration groups however. The increase in cancer incidence with employment duration largely relates to increases in prostate cancer and melanoma, which are discussed in more detail below.

The increase in overall cancer incidence for male part-time paid firefighters was not related to the duration of employment.

Compared to the Australian population there was a statistically significant reduction in most of the major cancer categories for male volunteer firefighters and no significant overall excess of cancer for female volunteer firefighters. For both groups of volunteers, there was no clear relationship with duration of service or with era of first service.

When the overall cancer rates for male career full-time, male part-time paid and male and female volunteer firefighters were compared internally, with a few exceptions, there was no trend of increasing overall cancer incidence with increasing duration of service or with increasing recorded number of incidents. Male career firefighters showed increased risks with more attendance at vehicle fires and there was a significant trend. Male volunteer firefighters showed a significant trend of increased risk of being diagnosed with cancer with increasing attendance at incidents when compared to those in the lowest tertile of attendance, but none of the individual risks were statistically significantly raised when compared to those who had not attended incidents.

Cancer incidence has almost complete capture by the ACD. A number of cancers now have a good cure rate so incidence is a better measure of disease than is cancer mortality. Monash therefore did not analyse mortality for separate cancer categories.

Findings related to specific cancer categories are discussed below.

9.1.1 Incidence of specific cancers

Lip, oral cavity and pharynx

Male paid firefighters did not show significantly increased risks in external or internal analyses with duration or incidents attended.

For both male and female volunteer firefighters, when compared to the Australian population, cancers of the lip, oral cavity and pharynx were higher than expected with increasing duration of service, but the risks were not statistically significant. Cancer of the lip was significantly increased for male volunteers who had served for more than 20 years and for male volunteers who commenced before 1970. Internal analyses showed an increase with duration for female volunteer firefighters, but not for male volunteers and the trend tests were not statistically significant.

In this study, there was little or no evidence of a link between firefighting and cancers of the lip, oral cavity and pharynx for paid firefighters but there were small numbers, particularly for internal analyses by employment duration and number of incidents attended. The data do not suggest that there is an association between an increased risk of lip cancer and volunteer firefighting. Evidence of an increased risk has, however, been reported in the previous literature, for cancers of the buccal cavity and pharynx, LeMasters et al found a Summary Risk Estimate (SRE)[8] of 1.23 (0.96 - 1.55)[9] [1] and a recent US study found an SIR of 1.39 (1.19 - 1.62).[6]

Digestive organs including oesophagus, stomach, colorectal, liver and pancreas

Compared to the Australian population, there were more colorectal cancers than expected for male career full-time firefighters but internal analyses by duration and incident did not show significant trends.

For male part-time paid firefighters, an internal analysis showed some evidence of an association between digestive system cancers and employment duration and number of incidents attended, but the trend tests were statistically significant only for duration and not for incidents attended.

For male volunteer firefighters, there was a trend of increasing digestive system cancer with increasing number of incidents compared to those with no incidents. However, the firefighters in tertile 1 were significantly less likely to develop cancer than those who did not have recorded incidents. None of the individual tertiles were significantly in excess, except

[8] A Summary Risk Estimate was calculated from the risk estimates across all available studies and includes mortality as well as cancer incidence

[9] All confidence intervals are 95% in this report.

for the highest tertile for attendance at structural fires for both male and female volunteers, with a trend that was statistically significant in men but not in women.

Compared to the Australian population, there were more rectal cancers among female volunteer firefighters, but the increase was not statistically significant. Female volunteer firefighters showed a monotonic increase with era of first service in colorectal cancers which was close to reaching statistical significance for those who first volunteered after 1994. Internal analyses showed no clear trends of increasing risk with duration or incidents.

In this study, there was some evidence of an association between increased risk of digestive system cancers and firefighting, but numbers were small. The literature also shows mixed results. LeMasters' meta-analysis found the following SREs, rectum 1.29 (1.10 - 1.51); stomach 1.22 (1.04 - 1.44) , colon 1.21 (1.03 - 1.41) [1] Another meta-analysis of only incident colorectal cancers gave a meta-incidence estimate (mIE)[10] of 1.18 (0.97 - 1.45) and stomach cancers of 0.99 (0.62 - 1.56).[2] In more recent studies, Daniels et al. found a significant excess of digestive tract cancers, SIR 1.17 (1.10 - 1.25) in US firefighters,[6] Kang found an excess of colon cancer among firefighters, compared to other cancers with a standardised morbidity odds ratio (SMOR) 1.36 (1.04 - 1.79)[25] and Ahn et al. observed a significant increase in colorectal cancer, SIR 1.27 (1.01 - 1.59) among Korean firefighters.[26] The literature therefore suggests an approximate 20 to 30% increase in colorectal cancers but less consistency in findings for stomach cancer.

Respiratory and intrathoracic organs including lung

Monash investigators had no information on smoking rates for individuals in the cohort and this is a major determinant of lung cancer. De-identified smoking data were available on a grouped basis, for firefighters from the CFA Healthwatch data for volunteers [27] and for career full-time firefighters from the FRNSW Health and Fitness Assessments.

In the Victorian general population, men smoke more than women[28, 29] but among Victorian volunteer firefighters, a higher proportion of women than men were smokers, although among smokers, women smoked fewer cigarettes than did the men.[27] Voluntary health assessments within FRNSW also indicate that a higher proportion of female firefighters than male firefighters were smokers, in contrast to the NSW general population where men smoke more than women.[30] Although these data have some limitations, they suggest that male firefighters may smoke less than the general population of men, which may contribute to the significantly lower than expected number of lung cancers found in this study for all three analysis groups of male firefighters.

[10] mIE is the risk estimate calculated from the meta-analysis of cancer incidence studies

In contrast, female firefighters may smoke more than the general population of women and the lung cancer rate was not significantly reduced for female volunteers. A US firefighters' study also showed that female career full-time firefighters smoked more than women in the general population.[31]

The respiratory cancer SIR reduced with duration category for paid male firefighters and was statistically significantly reduced for those who had served for over 20 years. This pattern of risk would be shown if smoking rates were lower for firefighters than for the Australian population. Internal analyses for male career full-time firefighters did not show an increase with increasing employment duration or with incidents attended for respiratory cancer.

For male and female volunteer firefighters, there was a monotonic increase by era for respiratory cancer, which was most strongly associated with first volunteering after 1994, but even this SIR was still significantly reduced. The risks for more recently recruited firefighters were closer to the population rates. The earlier decreases could be a consequence of lower smoking rates among male volunteers compared to the Australian population. The increase by era could be a result of a reduction in smoking among the Australian population to a level closer to that of the volunteer firefighters, i.e. a reduction in the smoking differential over time.

Internal analyses indicate no increase in lung cancer with tertile of incidents attended or duration of service, the trend test for duration showed a significant reduction in risk in men but not women. Volunteer firefighters in the highest tertile were significantly less likely to develop lung cancer than those who had not attended incidents.

These results do not suggest a relationship between firefighting and increased risk of lung cancer but effects may be masked by a lack of individual information on smoking. Lung cancer has not been shown to be increased in firefighters in most previous studies, SRE 1.03 (0.97 - 1.08) [1], mIE 0.96 (0.79 - 1.16) [2] but this would be difficult to show except perhaps among non-smoking firefighters.[3, 32] However, significant excess in lung cancers, SIR 1.12 (1.04 - 1.21) was found in a recently reported cohort of US firefighters.[6] A follow-up study of firefighters in Nordic countries also observed an excess of lung cancer, mainly due to the high relative risk of lung adenocarcinoma among older firefighters SIR 1.90 (1.34 - 2.62).[5]

Melanoma

Compared to the Australian population there were statistically significantly more melanomas than expected among male career and male part-time paid firefighters and female volunteer firefighters. There was no clear increase for female part-time paid firefighters or male volunteers. Melanoma was statistically significantly raised for full-time and part-time paid

firefighters both under and over 65 years, suggesting that this increased risk is consistent over the two age groups.

Melanoma was significantly increased for male career full-time firefighters in all eras, but for part-time paid firefighters, melanoma was most strongly associated with first employment before 1970. This suggests that the melanoma risk is consistent across era of employment for full-time firefighters, but is not as strong in more recent years for part-time firefighters.

When examined by duration of employment, male career full-time firefighters showed a significant increase in melanoma for the two longest duration categories in external analyses but not in internal analyses. Male part-time paid firefighters also showed a significant increase in melanoma incidence but only for the longest employment duration category and not in internal comparisons. Neither group showed an increased risk with number of incidents attended.

For male volunteers, melanoma rates were at population levels for the younger group and significantly reduced for the 65+ firefighter group. For female volunteers, melanoma rates were significantly increased for the younger group and at population levels for the 65+ firefighter group. Compared to the Australian population, melanoma was significantly reduced for firefighters who volunteered before 1970 (significantly so for men), was similar to population rates for the 1970 to 1994 volunteers and was significantly increased for those who first volunteered after 1994.

When examined internally and externally there was no relationship between service duration and increased risk of melanoma for male or female volunteers. Indeed the female firefighters who had served for less than 10 years were the only group with a significantly increased SIR.

The results indicate that there was some evidence of an increased risk for melanoma among paid firefighters, but there was less evidence that melanoma incidence was related to service as a volunteer firefighter. The significantly increased melanomas in the external analyses in all groups and periods do not appear to be related to duration or incidents in internal analyses.

Elevated rates of melanomas have been observed in other studies of paid firefighters SRE 1.32 (1.10 - 1.57) [1], and for incident melanomas mIE 1.46 (1.30 - 1.63).[2] Pukkala et al also found statistically significant excess melanoma among Nordic firefighters aged 30 - 49 years (SIR 1.62, 1.14 - 2.23).[5]

There is some previous evidence that firefighting is also associated with increased risk of other cancers of the skin.[1-3] Skin cancers, other than melanomas, are not collected by cancer registries in Australia, so the risk of this cancer could not be examined in this study.

Mesothelioma

There were more mesotheliomas than expected for male full-time and part-time paid firefighters, but the increases were not statistically significant compared to the Australian population. There was also an elevated mesothelioma rate for female volunteer firefighters but this was based on only three cases, so had limited statistical power. There is recent evidence that firefighting is associated with increased risk of mesothelioma in cohorts containing firefighters who started employment in earlier periods. In the US an SIR 2.29 (1.60 - 3.19) was observed [6] and a similar SIR 2.59 (1.24 - 4.77) was seen in a Nordic cohort.[5]

Mesotheliomas before 1997 were coded under the ICD-9 scheme which did not have mesothelioma as a specific code however all cancers have since been recoded from ICD-9 to ICD-10 by the Australian cancer registries. These findings, therefore, should not have been affected by this change in coding.

For male career full-time firefighters, mesothelioma, showed some increase with era of first employment with the highest SIR being associated with first employment after 1994 and among those career full-time firefighters who have served for less than 10 years but the numbers were small, limiting meaningful interpretation.

Mesothelioma typically has a latent period of 30-40 years.[33] In view of this latency, and the fact that few of the firefighters in this study started employment or voluntary service before 1985, it is unlikely that many employment-related mesotheliomas would have arisen yet. Employment related mesothelioma in this cohort of firefighters is unlikely to be seen for some years yet.

Breast

Compared to the Australian population, there was a reduced incidence of breast cancer for part-time paid female firefighters but this was based on only three cases and was not statistically significant. The number of breast cancers among female volunteer firefighters was close to that expected in the Australian population.

Male breast cancers are only about 1% of all breast cancers, so it is considerably less common than among women. There were more male breast cancers than expected for male career full-time firefighters but the increase was not statistically significant for the group as a whole. All five cases, however, were among those career full-time firefighters with 20+ years of service and this increase was statistically significant, which was suggestive of an increasing risk with increasing years of service. An excess of mortality from male breast cancer, a relatively rare tumour for which little is known about risk factors, was found in a US study of career firefighters (SMR 7.41; 1.99 - 19.0) but this excess was based on only four

deaths.[7] Previous meta-analyses were uninformative having wide confidence intervals mIE 1.05 (0.22 - 4.94).[2] LeMasters and the International Agency for Research on Cancer (IARC) did not include this site in their meta-analyses.

There was no significant increase in breast cancer incidence for male part-time paid or male volunteer firefighters.

Female reproductive organs including cervix

There was an elevated SIR for the female reproductive system for part-time paid firefighters but the numbers were small and the finding was not statistically significant. Trends by duration and incidents could not be analysed because of the small numbers.

Female volunteer firefighters showed reduction in the female reproductive cancers with era which was statistically significantly reduced for those first employed after 1994. There were higher risks of female reproductive cancers for volunteer firefighters who had attended more incidents and the risk was significantly increased for those who were in the highest tertile of landscape fires.

There were too few female career full-time firefighters to investigate these cancers further. There has been little published research on female reproductive cancers. A study in Florida found higher than expected rates of cervical cancer SIR 5.24; (2.93 - 8.65). [4] This study did not identify such a large increase in cervical cancer risk.

Male Reproductive Organs including prostate and testis

Male reproductive cancer incidence was statistically significantly raised for all three analysis groups compared to the Australian population, mainly because of the increased prostate cancer incidence.

Paid and volunteer firefighters who first served before 1994 showed a statistically significantly increased risk of prostate cancer, with the 1970-1994 group having the highest risk for career full-time firefighters. For male part-time paid firefighters, there was also a statistically significant increase in prostate cancer for those that were first employed after 1994. Compared to the Australian population, prostate cancer was statistically significantly raised for career full-time firefighters employed before and after 1985, but the increase was not statistically significant for the pre-1985 group. Internal analyses show that there was no difference in risk between these two groups.

The risk of prostate cancer was statistically significantly raised for those older and younger than 65 years, for both paid and the volunteer firefighters. When compared to the Australian population, there was an increase in prostate cancer for career full-time firefighters who had served for more than 20 years and for part-time paid and volunteer firefighters who had served for more than 10 years.

When compared within the cohort, male career full-time firefighters who served for 20+ years had a higher risk of prostate cancer to those who served for >3months but <10 years and it was significantly higher when compared to those who had been employed for between one and 10 years. Both analyses showed statistically significant trends. There were four prostate cancer cases among men who served for 3-12 months, these cases are unlikely to be occupationally related, given the likely latent period for prostate cancer. When these were removed, the risk estimate increased. There was also, for career full-time firefighters, a significantly increased risk of prostate cancer for the groups with the highest number of incidents recorded. There was a statistically significant trend of increasing risk with increasing incidents for all incident groups.

For part-time paid firefighters, the risk of prostate cancer was statistically significantly increased for the 10-20 year and 20+ year categories compared to those who had served for less than 10 years and the trend test was statistically significant. Some of the incident categories showed raised risk compared to tertile 1 but none were statistically significantly raised and there were no significant trends.

Prostate cancer SIRs showed a monotonic increase with service duration and were statistically significantly raised for those volunteer firefighters who had served for more than 10 years compared to the Australian population. Internal analyses also showed that the group of longest serving volunteer firefighters had a higher risk when compared to those who had served for shorter periods and there was a significant trend. There was no clear pattern with number of incidents attended however.

This suggests that firefighters were diagnosed with prostate cancer more commonly than the Australian population and that the risk increases with increasing years of service as a firefighter. The strongest effect was seen in career full-time firefighters. Elevated rates of prostate cancer have been observed in several other studies of firefighters.[3] Meta-analyses found the following risks for prostate cancer SRE 1.28(1.15 - 1.43)[1], mIE 1.21(1.13 - 1.31).[2] Recent studies reported an SIR for prostate cancer of 1.03 (0.98 - 1.09) [6] and for the age category of 30-49 years SIR 2.59 (1.34 - 4.52). [5]

Testicular cancer incidence was raised and was close to reaching statistical significance for career full-time firefighters but did not show an increase with duration of service or number of incidents attended. This would be unlikely however as testicular cancer cis more common younger men. For male volunteer firefighters, there were significantly raised rates of testicular cancer for firefighters in higher tertiles of duration and the trend test was significant. There were also significantly raised rates of testicular cancer for firefighters in some tertiles compared to those volunteers with no incidents, but the trend tests were not significant.

Meta-analyses found the following risks for testicular cancer in earlier studies SRE 2.02 (1.30 - 3.13),[1] mIE 1.57 (1.31 - 1.89).[2] Recent studies reported reduced SIRs for testicular cancer, SIR 0.75 (0.42 - 1.24)[6] and SIR 0.51 (0.23 - 0.98).[5]

Urinary tract including kidney and bladder

Compared to the Australian population, risk of urinary tract cancer was not statistically significantly raised for firefighters but there were increases seen in internal analyses.

The risk of urinary tract cancer was statistically significantly raised for male career full-time firefighters who had served for more than 10 years compared to those who had served for less than 10 years and the trend tests were positive.

For male career full-time firefighters, kidney cancer was non-statistically significantly elevated for those who had served for more than 10 years when compared to the Australian population. The risk was significantly increased for those who had been employed for over 20 years compared to those who had served for >3 months but < 10 years and was close to statistically significant for those who had served for at least one year but less than 10 years, both trend tests were statistically significant. The reference group, who had served less than 10 years had only one kidney cancer case, however, so these findings should be treated with caution. There were elevated RIRs for kidney cancer among male career full-time firefighters in tertiles 2 and 3 of incidents attended compared to those in tertile 1. None of the RIRs were statistically significantly raised and there was no significant trend with incidents.

There were too few cases among part-time paid firefighters to carry out internal analyses.

Among male volunteer firefighters, kidney cancers were not increased for the 20+ year category compared to those who had served for less than 10 years. No incident tertile had a significantly increased risk of kidney cancer compared to those who had not attended incidents but there was a significant trend of increasing cancer with increasing attendance at fires.

The risk of urinary tract cancer and kidney cancer were elevated for female volunteer firefighters for the highest tertile of some incident groups and the trend test across most incident groups was of borderline significance for urinary cancer.

Previous meta-analyses have not found convincing evidence of an association between firefighting and kidney cancer, SRE 1.07 (0.78 - 1.46)[1]; mIE 1.08 (0.58 - 2.02).[2] Increased risks have been reported in some recent studies, SIR 1.27 (1.09 - 1.48)[6] SIR 1.56 (1.01 - 2.41)[26] but not others SIR 0.94 (0.75 - 1.17).[5] In addition a non-significant excess of kidney cancer was identified among US firefighters SMOR 1.34 (0.90 - 2.01). [25

Brain and other CNS

No increase in brain cancer was seen for male career full-time firefighters or male volunteer firefighters. A higher than expected rate of brain cancer was seen for both male and female part-time paid firefighters, and in the case of women this was a statistically significant elevation, but these findings were based on a small number of cases.

For male part-time paid firefighters brain cancer SIR was significantly associated with first employment before 1970 but not with other periods, and again this was based on a small number of cases.

This study found some significant elevations in brain cancer, a relatively rare cancer. Previous studies have also found evidence of an association between firefighting and brain cancer.[32] Meta-analyses showed increases in risk of brain cancer SRE 1.32 (1.12 - 1.54)[1] and an mIE 1.16 (0.87 - 1.56)[2] but the latter was a non-significant increase. Most recent studies have not shown convincing evidence of a link between brain cancer and work as a firefighters; SIR 1.02 (0.76 - 1.34),[6] SIR 0.86 (0.66 - 1.10),[5] SIR 0.53 (0.14 - 1.36),[26] although a case control study of firefighters suggested an increased risk of brain cancer compared to other cancers SMOR 1.90 (1.10 - 3.26).[25]

Thyroid and other endocrine glands including thyroid

There was an elevated SIR for thyroid cancers for male part-time paid firefighters, particularly for those first employed before 1970 where it was statistically significant, but the numbers were small.

For male career full-time firefighters, thyroid cancer showed some increase with era of first employment with the highest SIR being associated with recruitment after 1994, but there was only a small number of cases and there were no statistically significant results.

Thyroid cancer incidence has previously been found to be raised for career firefighters in Florida in male SIR 1.77 (1.08 - 2.73) and female firefighters SIR 3.97 (1.45 - 8.65).[4] Thyroid cancer mortality was also elevated among male firefighters in the same cohort.[7] Significant increases were not found in other studies of cancer incidence in firefighters, mIE 1.36 (0.99 - 1.86),[2] SIR 1.28 (0.75 - 2.05),[5] SIR1.00 (0.60 - 1.56).[26] Excess cancers of thyroid were also apparent in New York City firefighters responding to the World Trade Center attack.[34]

Lymphoid, haematopoietic, myeloproliferative & myelodysplastic including NHL

When compared to the Australian population, male career full-time firefighters showed some increase in risk of NHL with era of first employment, with the highest risk being associated with recruitment after 1994, but there were no statistically significant results. Among male career full-time firefighters, the LH cancer risk, was statistically significantly raised for the two

groups who had been employed for more than 10 years compared to either of the groups who had been employed for less than 10 years and the trend tests were statistically significant. There were significant trends for NHL with increasing employment duration, and the risk was statistically significantly raised for those who had served for more than 20 years compared to those who had served for less than 10 years and again the trend was significant. There were no clear patterns of increased risk with increasing number or type of incidents attended.

For part-time paid firefighters the risk of LH was raised for those employed for more than 20 years compared to the lowest employment tertile and the risk and trend test were close to statistical significance, which is consistent with the findings for career full-time firefighters. There were, again, no clear patterns of increased risk with increasing number of incidents attended.

For male volunteer firefighters there was no increase in LH cancers with increasing service seen in external or internal analyses but there was a significant trend for male volunteer firefighters attending structural fires. Some of the LH cancer subcategories were elevated for female volunteer firefighters, but no clear pattern emerged and none were statistically significantly raised.

The LH cancer findings are consistent between the two male paid firefighter groups with significant or close to significant trends for duration of service in internal analyses but no observed association with number of incidents. Some studies of firefighters have also shown an increased risk of LH cancer (NHL, multiple myeloma (MM) and leukaemia),[3, 35] SIR 1.33 (0.91 - 1.87).[26] However a meta-analysis did not identify an increase in LH cancer, mIE 0.58 (0.31 - 1.06).[2] For the subcategories of LH cancer, the risks reported were also variable perhaps because the small numbers of the different LH cancers result in unstable risk estimates.

For NHL, where it was reported separately, the risks were: SRE 1.51 (1.31 - 1.73),[1] mIE 1.11 (0.96 - 1.29),[2] SIR 0.99 (0.85 - 1.15),[6] SIR 1.04 (0.83 - 1.29)[5], SIR1.69 (1.01 - 2.67).[26] A variation from no increase to a 70% increase.

For MM the risks were reported as: SRE 1.53 (1.21 - 1.94),[1] mIE 1.04 (0.76 - 1.41),[2] SIR 0.72 (0.50 - 0.99),[6] SIR 1.13 (0.81 - 1.53).[5] A variation from 4% to 53% increase.

For leukaemia the risks were: SRE 1.14 (0.98 - 1.31)[1], mIE 1.11 (0.93 - 1.33)[2], SIR 0.94 (0.77 - 1.15)[6], SIR 0.94 (0.71 to 1.22)[5], SIR 1.05 (0.56 - 1.79).[26] A variation from no increase to a 14% increase.

The cohort should be followed for a longer period, which will result in more events before convincing conclusions can be drawn for or against an association with firefighting for the subtypes of LH cancers in this cohort.

9.2 Cohort mortality

The overall mortality of the men and women in the three groups (career full-time firefighter, part-time paid firefighter and volunteer firefighters) in the cohort was statistically significantly reduced compared to that of the general Australian population. For the female part-time paid firefighters, although reduced, it was similar to that expected from the Australian population.

Industrial cohorts usually have a mortality rate lower than that of the Australian population because of the healthy worker effect which is discussed below. As a comparison, the Health Watch cohort of petroleum industry workers had a similar overall SMR of 0.72 (0.69 - 0.75).[36]

When examined by age group the reduction in mortality for the male groups of firefighters was more strongly associated with younger firefighters (under 65 years of age). All groups had significantly reduced mortality but the mortality of the older group was closer to that of the Australian population. This is also consistent with the healthy worker effect becoming less pronounced as a cohort ages.

Those male paid firefighters who had served for more than 20 years had a higher SMR than those who had served for a shorter time, but the risks were still reduced compared to the Australian population. This has been observed in other working populations, where the healthy worker effect reduces over time.[2]

9.2.1 Mortality by specific causes of death

Most major categories of death were statistically significantly reduced for male paid (career full-time or part-time paid) and male and female volunteer firefighters. There were too few female paid firefighters to investigate by specific death categories. The remainder of this section deals only with male firefighters and female volunteer firefighters.

Cancer Mortality

The SMRs for deaths from cancers were reduced for paid firefighters but less reduced than were other causes of death. For part-time paid firefighters, it was the only major cause of death that was not significantly reduced. The internal analyses showed increased relative risks of death from cancer for part-time paid firefighters although none were statistically significantly increased. The SMRs for deaths from malignancies was higher for those aged over 65 years than for those under 65 years for all analysis groups but did not show a

consistent relationship with duration of service. Most SMRs were statistically significantly reduced but the highest SMRs were for male career full-time and female volunteer firefighters who had served for more than 20 years.

All Circulatory Deaths including IHD

Deaths from cardiovascular disease were found to be significantly lower among firefighter groups than the Australian population in almost all analyses. The exceptions were for male career firefighters pre 1985, male part-time paid firefighters first employed before 1970 or who had served for more than 20 years where the reductions were not statistically significant; and for the pre-1970 group of female volunteer firefighters where the risk was the same as that of the Australian population.

A meta-analysis found heart disease among firefighters was the same as that of the general population mEI 1.00 (0.91 - 1.11)[2] but female firefighters had increased atherosclerotic heart disease (SMR 3.85 (1.66 - 7.58).[7] There is, however, evidence from the literature that deaths from coronary heart disease are linked to some specific firefighting duties.[17, 37] This cohort could not examine this because information about the activities being carried out just prior to the death was not available. A different study design would be needed to investigate this.

Career firefighters are selected for their physical health but volunteer firefighters have fewer entry requirements, (AFAC personal communication) but as Rosenstock points out, “they serve until an older age, when most cardiac events occur”. She noted that according to a USA report, “in 2005, of 115 deaths that occurred during on duty activities, 81 (70%) occurred among volunteer firefighters”.[38]

Internal analyses showed that for male career full-time firefighters those who had attended more incidents had a non-significantly higher risk of mortality than those in the lowest attendance group. The highest risk was associated with the middle tertile, which was significantly increased. There was no difference in deaths from circulatory disease by employment duration in internal analyses. Part-time firefighters showed a significant trend of increased risk of circulatory disease with increasing number of incidents attended.

Monash have no information on smoking rates for individuals in the cohort and this is a major determinant of cardiovascular disease. Extrapolating from the smoking data available for volunteers[27] and career full-time firefighters (see Section9.1.1), it is likely that male firefighters smoke less than the general Australian male population, which may contribute to the lower than expected cardiovascular mortality found in the study. In contrast, female firefighters may smoke more than the general population of Australian women.

All Respiratory Deaths

There is evidence from the literature that lung function may decline after work as a firefighter [39] but this may not manifest as deaths from respiratory disease.

In the absence of smoking data for individuals in the cohort, the findings for deaths from respiratory disease are difficult to interpret. Death from respiratory causes is associated with smoking so when compared to the Australian population; a reduction in deaths from respiratory disease would be expected among firefighters, if they smoke less than the Australian population.

More recently employed firefighters tended to have lower risk of respiratory deaths, but this is difficult to interpret in the absence of smoking data and is likely an example of the healthy worker effect, for example individuals with asthma might be less likely to become a firefighter.

There were too few respiratory deaths to carry out internal analyses by duration of service and number of incidents attended, except for volunteer firefighters where no particular trends were identified.

All Digestive Deaths

No clear associations were identified between deaths from digestive diseases and employment duration or voluntary service as a firefighter, or with era, age group or number of incidents attended, but numbers were small in many of the analyses.

All Injury and Trauma Deaths including suicide

When compared to the Australian population, suicide rates were statistically significantly reduced for the whole group of career full-time firefighters. It was elevated for those whose employment was complete before 1985 but not for those still employed after 1985.

In internal analyses, the risk of suicide was significantly reduced for the post-1985 group compared to the pre-1985 group. There was an increased risk of death from injury/trauma for male career full-time firefighters, particularly suicide, which increased with the number of vehicle fires attended. The increase was monotonic but none of the internal analyses or trend tests were statistically significant, but the numbers were small and the confidence intervals were wide.

For part-time paid male firefighters, the longer serving members were significantly less likely than the Australian population to die from injury or trauma and the trend was significant. Those who had served for shorter periods had rates that were closer to those of the Australian population.

Male volunteer firefighters had a statistically significantly increased risk of dying in a fire. The data provided by the NDI do not, however, distinguish between firefighters who died in the line of duty and those who died in fires when not on duty. From the dates of death, it would appear that eight firefighters died in two major bush fire events and these account for 42% deaths of the deaths from fire in this group.

For male volunteer firefighters, but not for female volunteers, increasing duration of service shows a statistically significant trend of reduction for deaths from injury/trauma including suicide, when compared to those with less than 10 years of service.

Female volunteer firefighters had a 30% increase in accidental deaths compared to the Australian population but the increase was not known to be related to accidents during volunteer activities. All accidental deaths would be included in these data. Twenty one of the 47 deaths were from car accidents and five from other land transport, two were fire-related. There was a statistically significant increase in accidental deaths for women who first volunteered after 1994. Internal analyses did not show that there was a relationship between duration of service or number of incidents attended and the risk of death from injury/trauma, so it is not clear how these deaths relate to firefighting activities.

9.3 Analysis by duration and era of employment/service

Duration of employment/service is a proxy for firefighting exposure. An increased risk with increasing exposure would suggest a risk that is related to employment. This was seen in external but not internal analyses for prostate cancer and melanoma for career full-time firefighters. Trends of increasing risk with increasing duration were seen in internal analyses for career full-time firefighters for prostate cancer, kidney cancer and LH cancer.

There was no increase in overall cancer or mortality for male or female volunteer firefighters with increasing duration of service in external or internal analyses.

Analyses by era (pre-1970, 1970-1994, 1995+) examined the death and cancer rates of those recruited in each of these eras in comparison to expected rates from the Australian population. For male paid firefighters the reduced SMRs particularly for more recent era of first employment could have resulted from improved work practices or personal protective equipment in recent years. There was no obvious pattern with era of first employment for male or female volunteer firefighters.

9.4 Employment before and after 1985

In 2012, diesel engine exhaust was declared a human carcinogen by the IARC, based on studies of lung cancer.[40] Diesel engine exhaust exposure has also been associated with increased risk of heart disease.[41] Diesel engine fire appliances were used by firefighters in Australia after 1985.

Male career full-time firefighters were divided into two groups, by whether or not their employment was complete before the end of 1985, which is before the introduction of diesel fire appliances. In these analyses, the cancer and mortality risk of those firefighters who were employed in/before 1985 or after 1985 were compared with the death and cancer rates expected from the Australian population. There were many fewer firefighters in the pre-1985 group because most agencies had only recent records available.

Career full-time firefighters from post-1985, showed significantly reduced mortality for most major causes of death compared to the Australian population. Those employed before 1985 did not show this reduction, in addition, when compared internally, those who worked after 1985, showed lower death rates from most causes than the pre-1985 group.

Career full-time firefighters who worked after 1985 were compared to those who had completed their employment by the end of 1985. Lung cancer incidence was significantly reduced for the post-1985 group compared to the earlier group which suggests that there was no likely effect from exposure to diesel exhaust particulate. However, it is possible that changes in smoking prevalence and/or improvements in respiratory protection that have taken place over this period might mask any such effect.

9.5 Analysis by number of incidents attended

This analysis assumes complete capture of attendance at incidents in the records provided to Monash. The number of incidents attended could be an underestimate of attendance, but was unlikely to be an overestimate. This is because even if all incidents were captured in the records, not all firefighters attending the incidents may have been identified and recorded as having attended. This was thought to be the case for Queensland volunteers, so their data were excluded from those analyses related to attendance at incidents.

For the incident analyses, firefighters were split into tertiles based on the number of incidents they had attended (Table 46). Any misclassification probably only affected those firefighters close to the cut points for the incident groups.

The numbers of incidents attended were estimated for individuals whose years of service occurred before the commencement date of incident data were being collected. This was

done by attributing the mean of the number of incidents attended in the years for which data were available to the earlier years. This resulted in some individuals being attributed a fraction of an incident. This also introduced some uncertainty into these analyses, which could have over or under estimated incidents in those earlier years if position titles had varied over that time.

As expected, on average, career full-time firefighters attend many more incidents than do part-time paid firefighters, the highest tertile cut point was 1,053 incidents for career full-time firefighters and 210 for part-time paid firefighters. Most volunteer firefighters attend fewer incidents, with women attending about half the number that men do, the third tertile cut points being 34.6 for men and 16 for women. The highest tertiles, included a small number of firefighters in each analysis group who had attended more than 5,000 incidents (Figure 1).

The division into tertiles creates groups with different frequencies of attending incidents with potential exposure. There is a wide range and reasonable differentiation between frequencies for the groups of male career full-time firefighters and, to a lesser extent for male part-time paid firefighters. The range of incident attendances is much smaller for male and female volunteer firefighters and the tertiles created for groups of male and female volunteer firefighters have only small absolute differences between them. This reduces the ability to investigate the effect of incident attendances on cancer or mortality risk in volunteer firefighters.

There are also differences between employed and volunteer firefighters in the types of fires attended. Landscape fires made up about 15% of the male career full-time firefighters' incidents, 33% of part-time paid firefighter incidents and 27% of the incidents that were recorded for volunteer firefighters. Therefore, a typical career full-time firefighter in the lowest tertile, is likely to have attended more landscape fires per year than most volunteer firefighters.

While the incident database provided information on the type of fire, it did not provide information on fire intensity or duration. Therefore, number of fires is a crude surrogate measure of exposure to potential hazards at fires. For example, some types of incidents go on for much longer than others, such as certain landscape fires which may go on for days or even weeks, which is rare for structural or vehicle fires. The analyses in this study have been unable to take these fire characteristics into account.

When compared to those with zero incidents, there were reduced numbers of deaths from all causes, of death from cancer and from circulatory disease for all groups of male volunteer firefighters. This may be because those firefighters who attend incidents are more likely to be in better health than those who never attend, although Monash did not have any data to

test this hypothesis. For volunteer firefighters who do attend incidents, increasing numbers of incidents appears to be associated with a trend of increases in overall deaths, of death from cancer and of death from injury/trauma and deaths from circulatory disease.

Volunteers from some states may attend more incidents than others but analysis by agency was not carried out.

9.6 Analysis for trainers

This analysis compared death and cancer incidence for those known to have been a trainer and for the rest of the cohort not known to have been a trainer, with that expected from the Australian population. Those trainers who specialised in hot fire training were identified from their job title and in some cases, in addition, from site of work. Other training jobs e.g. driver training or information technology training were excluded where possible.

The results suggest that trainers do not appear to have a higher death or cancer risk than other firefighters. The mortality of trainers who were career full-time firefighters was statistically significantly reduced compared to the Australian population and was, if anything, a little lower than that for career full-time firefighters as a whole. The mortality of trainers who were volunteer firefighters was similarly low but not statistically significantly reduced, but there were very wide confidence intervals as a result of the small numbers in the analyses.

The overall cancer SIR for male trainers who were career full-time firefighters was 15% raised (but not statistically significant) compared to the Australian population, while the SIR for the whole group of career full-time firefighters (combined trainers and non-trainers) was 8% higher than expected. For male volunteer trainers it was 40% reduced (but not statistically significant) compared to 24% reduced for the whole group of male volunteer firefighters.

The internal analyses suggest that male career full-time firefighter trainers have fewer overall deaths than expected but have the same overall rate of cancers when compared to non-trainers.

Three agencies, between them covering career full-time, part-time career and volunteer firefighters were unable to identify trainers from the job titles and this will have had two effects. Firstly, there will have been a loss of statistical power. There were only 1,878 male and 48 female trainers identified so that any cancer or death risk would have to be large to be identifiable. Secondly, there will have been misclassification in that trainers from those agencies will have been included in the comparison group (non-trainer firefighters) which will have reduced the differences between the groups (if any). Even for those agencies which

were able to identify trainers, the analysis was not able to take into account duration of being a trainer or the frequency of carrying out hot fire training, etc.

There were too few female trainers to calculate SMRs or SIRs, so no conclusions can be drawn.

9.7 Sources of uncertainty in the risk estimates

9.7.1 Possible ascertainment bias

The overall SMR data were examined for agencies with more than 20 deaths per analysis group, because smaller numbers tend to provide uncertain risk estimates. These SMRs by agency were between 0.25 and 0.82 for career full-time, part-time paid and volunteer male and female firefighters. Most of these values are within expectations for a working cohort. However the SMR for volunteers from one agency was only 0.26 for male and 0.25 for female volunteer firefighters, suggesting that there has been an ascertainment bias in these records. That is, the HR records were probably not retained on the HR system for individuals who had left (perhaps because they had died or become seriously ill), consequently the number of deaths may have been under-reported. As the firefighters from this agency make up only 11% of the volunteers and 8% of the person-years they have been included in the analyses and would be unlikely to have made a significant change to the overall findings.

The agency in question was unable to identify a date from when they were confident that the records were complete. When the mortality rate of this group of volunteers was estimated using a cohort start date of 2000 or later, rather than a start date of 2003 or later, the resulting SMR was slightly higher; which also suggests that there has been some incomplete historical ascertainment of employees.

The effect of this is that individuals who had left, perhaps because they had died or had contracted cancer would not be included, resulting in an underestimate of the true mortality and cancer incidence in the cohort and this would contribute to a healthy worker survivor effect (see Section 9.7.3).

9.7.2 Choice of population reference data for cancer risks

The choice of the comparison population is important in accurately assessing the cohort's risk of cancer and mortality. The cancer incidence of the cohort and its subgroups were compared to the Australian population after standardising for age.

However, some cancer rates vary by state, notably melanoma[42, 43] so for melanoma, state rates were used as a more appropriate comparison than Australian national rates. There

were no important state-effects identified in this reanalysis when compared with the analyses using the national data.

9.7.3 Healthy worker effect

When the mortality of occupational cohorts is compared with that of the Australian population, the mortality rate in the occupational cohort is typically lower. This is the well-established healthy worker effect.[44, 45] This effect has been shown in other firefighter cohorts in respect of mortality.[7, 46-49] One cause of the healthy worker effect is the relative social and economic advantage of employed people. Another factor is that people with life-threatening conditions, such as cancer and other chronic illnesses which increase the risk of death, are less likely to enter the workforce after diagnosis, further lowering the mortality rate in the workforce compared with the Australian population.

This healthy hire effect is thought to be particularly evident in career full-time firefighters who are selected in part on the basis of their high level of physical fitness.[44] All career fire agencies have strict entry requirements for fitness but as far as is known, medicals do not currently include cancer screening aside from the applicant disclosing medical and family history at the time of recruitment. It should be stressed that each agency has established its own standards, and these may differ between agencies. Volunteer firefighters, in most cases, do a self-declaration/disclosure of requested medical conditions, but no fitness assessment, with the exception of ACT Rural Fire Service (who are not included in this study). (AFAC personal communication 18/11/2014)

The healthy hire effect may be compounded by the healthy survivor effect whereby those who become ill leave the workforce.[45] Those firefighters who become ill, may leave the workforce early as they can no longer carry out this physically demanding job. At the time of the report (2014) there are no national standards in relation to fitness for duty. Most Australian fire services do not currently have periodic fitness or medical assessments except for return to work post injury, one exception is Air Services Australia firefighters who must comply with a CASA (Civil Aviation Safety Authority) medical every two years. Many of the agencies have voluntary health programs but in most cases, agencies have only provided aggregated information (e.g. CFA Healthwatch). Some of these voluntary health checks may include skin checks, but these would be *ad hoc*.

In 2002, AFAC published health and fitness monitoring guidelines for firefighters (see http://www.afac.com.au/docs/guideline/health-fitness.pdf?sfvrsn=18). AFAC are currently consulting with members to update these guidelines. (AFAC personal communication 18/11/2014)

In recent years prostate cancer has been diagnosed more often because of the availability of screening tests. To explain the increased rate in firefighters resulting from a diagnostic bias, firefighters would have to have been more likely than the general population to be screened. There was no evidence for this, based on information provided the agencies do not, offer the screening to firefighters but they may carry out health promotion activities (Advisory Committee member 26/11/2014). Monash reduced the impact of the healthy worker survivor effect by identifying a date from which each agency considered the HR records were a complete roll of firefighters at that time, and only including those firefighters and following up from that date (see Section 9.7.1). Once a complete roll was identified, the nationally complete mortality and cancer incidence registries would capture all deaths and cancers occurring among these firefighters even if they had left the agency.

Another way of dealing with this is to look at the cancer and mortality experience of the prevalent hires alone. However, the low number of prevalent hires and the relatively young age of the cohort meant that there were few deaths and cancers among the prevalent hires so this approach would have had low power (Table 14). It would be worth carrying out this analysis in future if the cohort is rematched and more events are identified.

In Table 18 and Table 19, the analyses by age group, most SMRs for the younger group of career full-time firefighters were low compared to the Australian population but for the older group, they become indistinguishable from those of the Australian population. This demonstrates the well-established observation that the healthy worker effect attenuates with age. This pattern was not seen for volunteer firefighters.

It might be thought that the healthy hire effect, operating in respect of paid firefighters, might have less of an effect for volunteer firefighters. However a proportion of volunteers become active in later years and those in the community who were less fit and less well were probably less likely to volunteer. As the majority of ill health occurs in later life, selection in this age group could be expected to have an important effect on the SMRs i.e. this selection bias could easily still apply. Indeed those male volunteer firefighters with more than 10 years of service had a significantly reduced SMR for Dementia/Alzheimers and diabetes. That is, longer serving volunteer firefighters are less likely to experience these diseases of old age than is the general population. The healthy worker effect may also occur within the male volunteer firefighter group, as those with no incidents recorded generally had a higher mortality than those who reported to attend incidents.

Internal analyses comparing the mortality and cancer incidence between groups of firefighters, was a way to limit the impact of the healthy worker effect in this study. That is comparing the risks of those who have served for less time or have had fewer exposures

with those who have served for a longer time or who were known to have experienced more exposures. In these analyses, the groups being compared would have been selected for employment/service in the same way as the reference group and therefore the healthy worker effect should have been minimised.

9.7.4 Identification of deaths and cancer cases

Cancer and death registration is mandatory in all Australian States and Territories, and registration, including for cancer, is virtually complete. [50] Cancers diagnosed overseas and not treated in Australia and deaths occurring overseas are also not included.

Non-melanotic skin cancers are not reportable however, so data on basal cell and squamous cell skin cancers were not collected and are not included in the analyses presented here.

Matching the cohort names to those in the NDI and ACD is a probabilistic process. Some deaths and cancer cases may be missed e.g. where names were spelled wrongly or dates of birth were wrong, either in the data supplied by the agencies or in the cancer and death registries, or both. The linkage process included similarly spelled names and common shortenings e.g. Bob for Robert, so few cases should be missed because of this. However, it was also possible that matches have been made with people who were not in the cohort but who had similar names and dates of birth i.e. there may be deaths/cancer cases in the analyses that should not have been included. Monash University carried out a thorough clerical review of the possible death matches and are confident that all of the good quality matches were included. The clerical review of possible matches for cancer cases was done by the AIHW, using well-established protocols, so, again, this factor is likely to have only a small impact on the validity of the findings.

Previous validation studies of the NDI have found good sensitivity and specificity of the matching process, with sensitivity (chance of finding a true match) between 88% [51] and 95%, [52] and specificity (chance of rejecting a false match) of about 98%. [51, 52]

9.7.5 Sensitivity analyses

There were some firefighters who, according to their volunteer records, were still active volunteers at a very advanced age, well over 80 years old. It was unclear whether these people were alive and genuinely still active volunteer firefighters or their records had not been updated or deleted when they left the service. If a person had died before 1980 they would not appear on the NDI and their record would not be found and matched. The sensitivity analyses that removed all volunteer firefighters born in or before 1925, resulted in little change to the SMRs, so any effect from this possible data quality problem was negligible.

Equally, removal of those who had served for less than one year had little effect on the calculated overall SMRs. Short-term workers are known to have a higher mortality than longer term workers and this is thought to relate to a less healthy lifestyle.[53] Short-term employees may also have had data quality problems with their employment or volunteer records and may have been misclassified.

For the internal career full-time firefighter duration analyses, removing individuals who had had been employed for more than three months but less than one year had two effects. Firstly if the person years but not the number of cases in the reference category decreased e.g. kidney cancer, the risk will increase for the comparison categories. Secondly if cases and person-years are removed the risk may increase e.g. prostate cancer or decrease e.g. cancer of the testis. If the baseline category has few cases the effect may be large.

The majority (97%) of agency-notified firefighter deaths were identified on the NDI for both men and women. Sensitivity analyses showed that the missing notified deaths had little or no effect on the overall SMRs.

There did not appear to be significant heterogeneity in any of the cohort groups of men or for the female volunteer firefighters, when results for the under 65 year group were compared to those over 65 years old. A majority of ill health appears in later life and a significant difference in the SMRs or SIRs between the two groups would suggest that the groups should not be combined in analyses as they were experiencing differential trends in health compared to the Australian population. This did not appear to be the case in this study.

9.7.6 Latent period

It was generally considered that there is a latent period between first exposure and diagnosis of cancer. The latent period can be short with perhaps 10 years for leukaemia,[54] around 10-15 years for many solid tumours[32] and can be 30-40 years for mesotheliomas.[33] In view of this latency, it was unlikely that many cancers in this cohort would have arisen before 1982 when the ACD was complete. However if exposure only started in 1995, it is probably too early for many solid tumours to have developed as yet and this emphasises the need to continue to monitor the cancers occurring in this cohort into the future.

9.7.7 Exposure metrics

The firefighters were grouped in a variety of ways to investigate the risks of mortality and cancer incidence and the limitations are discussed here.

The most important grouping was that of career full-time and part-time paid and volunteer firefighters. The cohort contained firefighters who could have been allocated to more than one group, e.g. career full-time firefighters who were also volunteers. Appendix 2 provides

details of how these were handled. Part-time career firefighters with only a brief period of full-time employment were allocated to the career full-time firefighter group.

Retained and auxiliary firefighters were grouped as part-time firefighters, although the nature of the work pattern may be different. Figure 1 suggests that the grouping reflects the lower average number of incidents attended by part-time firefighters.

For part of the analysis, firefighters were grouped using the incident data i.e. grouped by number of incidents attended, by fires attended and by car fires, structural fires and landscape fires attended. Table 1 shows the dates for which the incident and HR data were complete by agency. In most cases the dates are similar. For MFB, the incident data were only complete from 10 years after the HR data were complete but the HR data started in 1980, which was some time before most other agencies.

There may have been some misclassification in the incidents attributed to individuals. It was considered unlikely that a full-time or part-time paid firefighter would never have attended an incident. It is possible that the firefighters without recorded incidents were no longer in frontline roles when the incident recording system started and therefore had no recorded incidents. It was likely that they were active attendees in the past, before the incident recording system was in place. If individual paid firefighters had no incidents recorded in the incident data from their agency, it was not possible to estimate their likely attendance at incidents in the past and they were excluded from this part of the analyses. However, this only related to a small proportion of people in the cohort (Figure 2).

It is possible that some firefighters currently holding more senior roles were included in the analyses with too few incidents recorded. That is their historical attendance was underestimated by estimating attendance from incidents recorded for recent jobs. It was not feasible to individually assess each firefighter to allow for this, but it is also likely to have involved only a small proportion of people in the cohort.

Another possibility is that the recording system did not completely capture all the individuals at each incident and some individuals were missing from records. This would also tend to reduce the observed number of incidents attended by some individuals. Monash was informed that this was the case for the volunteer firefighters in Queensland who were omitted from the analyses involving incident data, but it may also have happened in other agencies to a lesser extent.

If the incident data from agencies did not include complete capture of incidents for each individual firefighter there is scope for some misclassification. If this is non-differential misclassification, i.e. is similar among all groups studied, this would usually lead to a reduction in the observed risks.[55]

On average volunteer firefighters typically attend many fewer incidents than career full-time firefighters and part-time paid firefighters. There was a wide range of the number of incidents attended however, and some volunteers have attended more than a thousand incidents. The tertiles of incident attendance for career full-time firefighters display larger absolute differences than do those for volunteer firefighters. It is more likely therefore, that tertiles of incident attendance would be able show a dose effect relationship for career full-time firefighters than would tertiles for volunteer firefighters because the exposure differences between the groups would be bigger.

Other possible metrics that were considered for the study included:

1. Busyness of the station/brigades

   Urban firefighters are reassigned between stations on a regular basis and the busyness has changed over time. For volunteer firefighters it was initially planned to construct a metric looking at periurban versus rural/remote brigades as proxy for type of fire and frequency where data are available. Most agencies, however, indicated that their basis for this metric would be their incident data and so this would not have been a metric independent of that created from the incident data.

2. Type of uniforms, BA, fire suppressant foams, vehicle exhaust extraction.

   Information was gathered across the agencies on:

   - Type of uniforms and when agency cleaning was introduced (versus firefighters' cleaning the uniforms);
   - When the various types of respiratory protective equipment (RPE) including BA became available and when RPE was routinely used at fires by most firefighters;
   - Type of fire suppressant foams used;
   - Installation of local exhaust extraction for vehicles in the fire station.

   However inter-agency and intra-agency differences in types of equipment foams, etc. used and dates of change made it too complex to construct a metric that could be confidently used across the cohort.

3. Shift patterns

   For career full-time firefighters, the current 10/14 shift pattern was established in the 1970s and applied to all the agencies in this study so there was no suitable comparison group who had not worked this shift pattern.

9.7.8 Other possible confounding factors

There were other potential confounding factors that could affect the observed risk estimates for some cancers and deaths, which could not be measured or accounted for in this study design. The study could not take into account individual genetic, or lifestyle factors such as

ethnicity, smoking, alcohol consumption, diet or non-firefighting job exposures experienced, for example in previous jobs and for other jobs held by firefighters. These factors may increase or decrease risk of some cancer and mortality outcomes. Ethnic origin was not identified in agency records and therefore could not be investigated. Genetic factors play a part in the risk of some diseases. For example prostate cancer is more common among African Americans than Caucasian Americans[56] and those with paler skin who do not tan easily[57] are more susceptible to melanoma. For melanoma, sun exposure is an important risk factor, but no information was available on this for the cohort members on an individual basis.

There was a significant reduction in respiratory cancers, non-malignant respiratory mortality, mortality from ischaemic heart disease and COPD, all of which are associated with smoking, which may indicate that firefighters smoke less than the general population. There was some support for this for volunteer firefighters in analyses of the CFA Healthwatch data, although these data may not be representative of all volunteer firefighters,[27] and for career full-time firefighters from NSW data, see Section 9.1.1.

9.7.9 Statistical power of the study

The power of this study to determine risk associated with cancer or specific causes of death was limited by the small numbers for the less common cancers and the short period of follow up for some members of the cohort. The mean age at the end of the study was under 50 years for all the groups of firefighters. Most deaths occur later than this, including from cancer which is primarily a disease of old age. This means that it is only possible to identify relatively large statistically significant increases or decreases in specific cancers or causes of death. The study was sufficiently powered to identify significantly increased risks of most major cancer and death categories for male paid and volunteer and female volunteer firefighters. Internal analyses comparing risk by duration of service or number of incidents attended was limited, particularly for women.

9.7.10 Multiple comparisons

As noted in 7.11.4, the formal test for statistical significance, that the 95% confidence intervals do include one. This implies that there is less than a one in 20 probability that the finding is due to chance, i.e. is due to random variation. However when more than 20 risks estimates are made, it becomes more likely that one of these may be a chance finding.[58]

The number of calculated risk estimates was large in this study. For example, for internal comparisons, there were eight major categories of cause of death, including an overall risk estimate, for each of the six groups (male and female; career, part-time paid and volunteer). There were 14 major cancer categories including an overall cancer risk estimate, for each of

the six groups. These death and cancer categories were also examined by duration of service, era of service and service before or after 1985 in internal and external analyses. It is important, therefore, to look at the overall patterns of results, rather than focus on single isolated findings when interpreting the study results.

9.8 Further research

Now that the cohort has been assembled and a database constructed for linkage to the NDI and the ACD, regular linkages into the future can be undertaken in a very cost-effective manner. There have been relatively few deaths and cancers so far because the cohort is relatively young and has a high proportion of current employees. As the cohort ages, more of cancers and deaths will accumulate and this will increase precision of the risk estimates. Future linkages are therefore likely to give more robust estimates of cancer and mortality risk. Members of the Technical Reference Group have independently endorsed this suggestion.

The NDI linkage was carried out to 30/11/2011 to identify causes of death. The cancer linkage was completed to 2010 but only until 2009 for NSW and ACT. Following the cohort into the future, and rematching to the NDI and ACD would result in an increased number of deaths and cancers, which would increase the power to detect any increases in risk, in particular for rarer cancer types. It would also provide the opportunity to assess the mortality and cancer experience of the prevalent hires which would reduce any survivor bias.

Table 15: Cancer projections over the next five years

		Cohort end 2010		Cohort projected for 5 years	
		Observed	Current Expected	Projected Expected	Relative Increase %
Kidney	Male Career	33	34	49	42.9
	Male Part-time	19	14	22	52.3
	Male Volunteer	196	240	373	55.3
	Female Volunteer	19	19	31	59.3
Brain	Male Career	16	21	29	36.7
	Male Part-time	12	9	13	45.4
	Male Volunteer	114	129	201	55.9
	Female Volunteer	13	14	20	41.6
NHL	Male Career	47	48	69	43.3
	Male Part-time	19	20	30	51.2
	Male Volunteer	267	322	519	61.5
	Female Volunteer	38	38	58	53.6

If the cohort were matched again in five years, the expected numbers for three cancers of interest, based on projections from current rates are shown in Table 15. This projection takes into account the age structure of the existing cohort and current population cancer rates. Based on these projections, there would be a 40-50% increase in the number of these cancers, which would allow more definitive interpretation of the findings.

Further work could also be directed at obtaining more complete job histories and other measures of exposure and for this information to be included in analysing the results of future linkages for this cohort. The recording of incident data provides a unique opportunity to follow prevalent hires with a complete history of all incident attendance.

It would be worth undertaking additional analyses on the cancer incidence and mortality for volunteer firefighters, excluding those who do not have incidents recorded. Firstly the internal analyses suggest that those who do not attend incidents appear to be less healthy than those who do attend incidents. This is a form of the healthy worker effect akin to the healthy warrior effect seen in the military where those who are deployed tend to be healthier than those who are not deployed.[59] This would underestimate the health risks amongst volunteers who do turn out. If volunteers have never turned out, and there are a substantial proportion of volunteer firefighters in this category (approximately 33%), they will not have had any exposure except in training. The mortality and cancer incidence of these unexposed volunteers could dilute any effects seen in the remainder of the volunteers.

It may also be worth examining the health of those in the highest group of incidents attended against the health of the rest of the volunteers, given the wide variation in the number of incidents attended and the small absolute differences in the tertiles created. It would be interesting to use the same absolute cut points as those used for the career firefighter incident analyses. The large number of volunteer firefighters in the cohort will make this a feasible analysis.

There may also be possible to identify more historical records from the agencies to capture more previously serving paid firefighters to increase the power. The data were only complete from 2000 for most agencies, limiting the utility of the cohort to examine firefighter mortality and cancer incidence. The newly hired employees could also be added which might, in particular, increase the number of female paid firefighters in the cohort.

There is evidence from the literature that deaths from coronary heart disease are linked to some firefighting duties.[17] It may be possible in future to investigate whether there is a link between the attendance at an incident with death from heart disease by examining the date of death and the date of attendance at an incident in a time series analysis.

More information on smoking and other lifestyle factors for firefighters would be useful to obtain. These may explain differences between their mortality and cancer incidence and those of the Australian population.

In recent years, other public health data sets have become available for linkage to cohorts. These include hospital emergency department and inpatient data, as well as Medicare and Pharmaceutical Benefits Scheme data. Linkage to these data sets would provide a better insight into chronic (non-cancer) diseases experienced by firefighters, especially those which do not result in death. These linkages may require individual consent.

The investigation of other important health outcomes, such as reduced lung function or mental health outcomes, will need a different research methodology. Suicide is an uncommon outcome and, although a very serious problem, is an inadequate measure of overall mental health problems. Linkage of the firefighter cohort with other public health data sets, as discussed above, could provide some insight into mental and other health problems which cause morbidity, but not death.

Another method to better investigate such health outcomes would be to establish new smaller cohorts with direct data collection from the participants or cross sectional surveys with a longitudinal component, including data linkage.

10. Conclusions

When compared to the general Australian population, the overall mortality of the cohort of firefighters was significantly decreased for the men in the three analysis groups and for female volunteer firefighters. This is likely to be a result of the healthy worker effect and perhaps some under ascertainment of cases and in male firefighters, the likely lower smoking rates. No major categories of death were statistically significantly elevated for men or women in any of the three analysis groups examined but deaths from cancer were less reduced than deaths from other causes.

The mortality results are summarised in Table 16. The overall cancer incidence results are summarised in Table 17

Table 16: Mortality for the cohort as a whole and excesses from sub-analyses
Overall findings are in **bold**

Cause of Death	Male Full-time	Male Part-time	Male Volunteer	Female Volunteer
All Causes of Death	↓↓	↓↓	↓↓ Incident T	↓↓
Malignancies	↓↓	=	↓↓ Incident T	↓↓
Nervous system	=	↓↓	↓↓	↓↓
Circulatory	↓↓	↓↓	↓↓ Incident T	↓↓
Respiratory	↓↓	↓↓	↓↓	↓↓
Digestive	↓↓	↓↓	↓↓	↓↓
Injury & Trauma	↓↓	↓↓	↓↓ Structural T Vehicle T	=
All Accidents	↓↓	=	↓↓	↑
Fire	=	=	↑↑	=
Suicide	↓↓ Pre 1985 Ext	↓↓	↓↓	=

Key

↓↓	Statistically significant decrease	Ext	From external analyses ie SMR or SIR
=	No increase	T	Significant positive trend
↑	Non-statistically significant elevation	Incident	Sig excess for one or more incident category

Table 17: Cancer incidence for the cohort as a whole and excesses from sub-analyses
Overall findings are in **bold**

Cancer Categories	Male			Female	
	Full-time	Part-time	Volunteer	Part-time	Volunteer
All Malignancies	↑↑ >20 Ext Post 1985 Ext Landscape Vehicle T	↑↑	↓↓	↑	=
Lip, Oral Cavity etc.	=	=	↓↓ >20 Ext		=
Lip	=	=	↓↓ Pre1970		=
Digestive Organs	=	= >20 Int T	↓↓ Incident T	=	=
Stomach	= Pre 1985 Ext	=	↓↓		↓↓
Colorectal	= Landscape	= >20 Int T	↓↓ Incid T		=
Respiratory	↓↓	↓↓	↓↓		=
Lung	=	↓↓	↓↓		=
Melanoma	↑↑ >10, >20 Ext All eras Post 1985 Ext	↑↑ >20 Ext Pre 1970	= 1995+	=	↑↑ <10 Ext 1995+
Mesothelioma	↑ <10 Ext	=	↓↓		=
Breast	↑ >20 Ext	=	↓↓	=	=
Female Reproductive	n.a.	n.a.	n.a.	↑	↓↓ 10 - 20 Int
Cervix	n.a.	n.a.	n.a.		↓↓
Male Reproductive	↑↑ >20 Ext 1970-1994 Post 1985 Ext Incidents T	↑↑ >10, >20 Ext 1970-1994	↑↑ >20 Ext Pre 1970 -19 94 >20 Int T	n.a.	n.a.
Prostate	↑↑ >20 Ext Pre 1970 -1994 Post 1985 Ext Duration T Incidents T	↑↑ >10, >20 Ext All eras >10, >20 Int T	↑↑ >10, >20 Ext Pre 1970 -1994 >20 Int T	n.a.	n.a.
Testis	↑ Post 1985 Ext	=	= >20 Int T Incidents	n.a.	n.a.
Urinary Tract	= >10, >20 Int T	=	↓↓		=
Kidney	= >20 Int T	↑	↓↓ Incid T		=
Brain & CNS	=	= Pre 1970	=		=
Brain	=	↑ Pre 1970	=	↑↑	=
Thyroid & Endocrine	=	= Pre 1970	=	=	=
Thyroid	=	= Pre 1970	=		=
LH	= >20 Int T	=	↓↓ Incid T		=

Key

↓↓	Statistically significant decrease	<10	Sig excess for less than 10 years of service
=	No increase	>10	Sig excess for more than 10 years of service
↑	Non-statistically significant elevation	>20	Sig excess for more than 20 years of service
↑↑	Statistically significant increase	Incident	Sig excess for one or more incident category
Ext	Increase from external analyses i.e. SMR or SIR	Dur T	Significant positive trend for duration
Int	Increase from internal analyses i.e. RMR or RIR	Incid T	Significant positive trend for incident
n.a.	Not applicable		

Male career full-time firefighters

For male career full-time firefighters, overall mortality rates, and mortality from respiratory and circulatory causes were lower than for the Australian population, in line with the healthy worker effect and likely reduced smoking rates. When compared to the Australian population, the suicide rate was statistically significantly reduced for all career full-time firefighters but was elevated for those whose employment was complete before 1985 but not for those with employment after 1985. In internal analyses, the risk of suicide was significantly reduced for the post-1985 group compared to the pre-1985 group.

In contrast to most of the mortality outcomes, cancer incidence was raised for male career full-time firefighters compared to the Australian population and this was most strongly associated with significant increases in prostate cancer and melanoma. Prostate cancer and melanoma were significantly elevated in several analyses and were most evident for those who had been employed for more than 20 years in external analyses. Prostate cancer also showed a trend with duration and incidents in internal analyses but melanoma did not.

Lympho-haematopoetic (LH) cancer specifically NHL, occurred at the same rate as the Australian population for the career full-time firefighters as a group but was significantly elevated for both groups of those who had worked for more than 10 years, when compared to the Australian population and when compared to those who had worked for less than 10 years and there was a significant trend with duration. Internal analyses did not show a trend with incidents attended.

Kidney cancer was increased for those who had served for 10-20 years when compared to the Australian population and significantly increased for those who worked more than 20 years compared to those who worked for between three months and 10 years and there was a positive trend with employment duration, but this finding is based on only one case in the comparison group, so this finding needs to be treated with caution. There was no trend with number of incidents attended.

There were more cases of testicular cancer in career full-time firefighters than expected, but the numbers were small and the finding was not statistically significant.

When compared to the Australian population, male breast cancer was elevated but did not reach statistical significance, it was however, statistically significantly increased among those employed for more than 20 years.

Compared to the Australian population, mesothelioma was statistically significantly increased for those male career full-time firefighters who had served for less than 10 years, but not for those in longer employment duration groups, but these analyses were based on small numbers.

When compared to the Australian population stomach cancer was not increased but it was significantly raised for those firefighters who worked before 1985 but not for those employed after this date. Internal analyses did not show clear trends with duration or incidents.

Lung cancer incidence was non-statistically significantly reduced when the group as a whole was compared to the Australian population, there was no a trend with duration of employment or incidents attended. It is likely that career firefighters are less likely to smoke and smoke less than the general population.

Trainers do not appear to have a higher death or cancer risk than other firefighters but numbers were small.

Male part-time paid firefighters

For male part-time paid firefighters, overall death rates, and death from respiratory and circulatory causes were lower than for the Australian population also in line with the healthy worker effect and likely reduced smoking rates.

Cancer incidence was significantly raised by 11%, compared to the Australian population but was not related to employment duration in external or internal analyses.

There were increases in prostate cancer which were related to employment duration in external and internal analyses but there was no trend with incidents attended. Melanoma incidence was increased particularly for the 20+ duration group in external analyses. There was no significant trend with duration or incidents in internal analyses.

Digestive tract cancers were significantly raised for firefighters with more than 20 years employment compared to those with less than 10 years employment and the trend was significant but there was no relationship with incidents attended. Other cancers for which there was some evidence of an excess were brain and thyroid cancers for those employed pre 1970, and possibly LH cancer and mesothelioma but the numbers were small, limiting interpretation.

Male volunteer firefighters

Male volunteer firefighters had lower overall death, cancer death and cancer rates than the Australian population. They had an increased risk of dying in a fire, which was probably related to two major bush fire events in the past, increasing duration of service did not increase the risk of a traumatic death. For volunteer firefighters who attended incidents, increasing numbers of incidents appeared to be associated with a trend of increases in overall deaths, cancer incidence and of death from cancer and from circulatory disease but the mortality of the group as a whole is significantly less than that of the Australian population.

In terms of cancer incidence, there was no overall increased risk of cancer, or increased risk with duration of service, but there was a trend of increased cancer with the incidents attended. The strongest association was with prostate cancer, where there was a monotonic increase in risk with service duration, the risk was statistically significantly raised for those who had served for more than 10 years compared to the Australian population. Internal analyses showed an increased risk for those who served for more than 10 years but no trend with the number of fire incidents attended.

Melanoma risk does not appear to be related to service for male volunteers

Testicular cancer was not increased when male volunteers were compared to the Australian population but was significantly increased for those volunteers who have attended fires compared to those who have not attended fires. It was also significantly increased for those volunteers who served for more than 20 years when compared to volunteer firefighters who served for less than 10 years (with a significant trend) and raised but not significantly so when the 20+ group were compared to the Australian population. There were also significantly elevated risks for some incident tertiles but there was no trend in risk.

Kidney cancer was not elevated when compared to the Australian population or when examined internally by duration. There were very few cases of kidney cancer but there was a trend of increased risk with attending fires.

LH cancer was not in excess overall and there was no increase with increasing service in external or internal analyses but there as a significant trend for male volunteer firefighters attending structural fires.

There was some evidence of an association with cancer of the lip for those employed pre 1970 compared to the Australian population but no evidence of increased risk in internal analyses by duration or incidents attended.

There was no overall increased risk of digestive system cancers, or increased risk with duration of service, but there was a trend of increased cancer with the incidents attended.

On average volunteer firefighters typically attend fewer incidents than career full-time firefighters and part-time paid firefighters. The tertiles of attendance for career full-time firefighters display larger absolute differences than volunteer firefighters. It is more likely therefore that tertiles of attendance would be able show a dose effect relationship for career firefighters than would tertiles for volunteer firefighters.

Female firefighters

For female career full-time firefighters there were too few deaths or cancer cases for meaningful analyses. The limited data suggested that their risks were not higher than that of the Australian population. For female part-time paid firefighters there were too few deaths for meaningful analyses but there was no observed increased risk.

There was an elevated rate of brain cancer, thyroid cancer and melanoma with weaker evidence for female reproductive cancer, but these were based on small numbers of cases and only brain cancer incidence was statistically significant.

Female volunteer firefighters also had lower overall death and cancer death rates than the Australian population but a somewhat higher risk of accidental death but this was not necessarily associated with firefighting activities.

The cancer incidence was similar to that of the Australian population, lower for female reproductive system cancers but higher for melanomas but the risk does not appear to be related to service.

There were no significant associations or trends with duration or significant trends for incidents in internal analyses. Female reproductive cancers were elevated for female volunteer firefighters in the highest tertile of vehicle fires.

There was a little evidence of increased colorectal cancers for those who first volunteered after 1994 and for those in the highest tertile of structural fire incidents.

Other Matters

The differences in findings between the career full-time, part-time paid and volunteer firefighter groups showed that it was both appropriate and necessary to analyse the cancer and mortality separately for these three groups. This is the first study to investigate the cancer and mortality of a cohort of volunteer firefighters.

The pattern of mortality and cancer incidence findings were similar for male career full-time and part-time paid firefighters but the overall cancer and prostate cancer findings were stronger for full-time firefighters than part-time firefighters, which is suggestive that these are

employment-related effects. There was a consistency among male firefighters with respect to the increase in LH cancer with duration of service from internal analyses.

The analyses here are based on small numbers of cancers for several less common cancers, such as bladder cancer and sub types of LH cancers. The analyses for female paid firefighters in particular, often have wide confidence intervals and so the point risk estimates should be interpreted cautiously.

Further follow up is recommended in five years when the larger number of cancer and death events as the cohort ages will increase the statistical power of the study and so provide more precision in the risks of causes of death and types of cancer particularly for the less common cancers such as kidney cancer.

In terms of the other cancers being investigated, there was a little evidence for an increase in digestive system cancers specifically colon or rectal cancers. There was no evidence in male firefighters of an increase in bladder cancer, multiple myeloma or leukaemia but there was insufficient power to investigate most of these rarer cancers. In women there was no evidence of an increase in cervical cancer, thyroid cancer or breast cancer but numbers were limited for paid female firefighters.

For solid tumours, such as mesothelioma, the young age of the cohort and the known long latency period means that any increase in risk may not be identified for some years and this emphasises the need to undertake future linkages of this cohort.

While this study has some strengths, including the large size, especially for volunteer firefighters and the ability to access nationally complete death and cancer databases, there are some limitations, in particular no information being available about individual lifestyle factors such as smoking.

There were also some limitations in firefighter exposure assessments, the study relied on surrogates, such as attendance at incidents, which may impact on the strength of conclusions which can be drawn from the internal analyses.

Glossary

From: Goddard, D. (2002) *Glossary of Terms Relating to Occupational Health & Epidemiology.* Department of Epidemiology and Preventive Medicine, Monash University, Melbourne.

Association (in epidemiology)
A finding of co-existence between exposure to an agent and a changed (usually increased) incidence of disease brought about because (1) the exposure causes the disease, or (2) the disease brings about the exposure, or (3) there is confounding. Causation is a sub-set of association; they are not identical. It is the extent to which the occurrence of two or more characteristics are linked either through a causal or non-causal relationship.

Bias
A non-random error in an epidemiological study that leads to a distorted result.

Case
A person with a disease of interest.

Causality
The extent to which a particular exposure is responsible for the subsequent occurrence of a disease.

Cohort
A group of persons who share a common attribute, such as birth in a particular year, residence in a particular town or exposure to a particular agent, and who are observed over a period.

Cohort study
An observational study in which subjects are sampled based on the presence (exposed) or absence (unexposed) of a risk factor of interest. All cohort studies proceed forward in time from exposure (or not) to health outcome, although the exposure status may be decided either from historical record or determined after the study commences.

Confidence interval
A range of values, calculated from the sample observations that are believed, with a particular probability, to contain the true parameter value. A 95% confidence interval, for example, implies that, were the estimation process repeated again and again, then 95% of the calculated intervals would be expected to contain the true parameter value. Other confidence intervals often used are 90% and 99%.

Confounding
An association between an exposure of interest and a disease which is not directly causal but where both exposure and disease are linked by their association with a third factor. It has the potential to bring an error in the interpretation of the results of a study.

Correlation
Describes the direction and strength of a straight-line relationship between two variables.

Decile
Is any of the nine values that divide the sorted data into ten equal parts, so that each part represents 1/10 of the sample or population.

Dose-response relationship
A relationship in which a change in amount, intensity or duration of exposure is associated with a change in the risk or severity of a specified outcome.

Epidemiology
The study of the distribution and determinants of disease in groups of people i.e. who suffers what and why.

Exposure
The presence of a noise, substance or form of radiation in the environment of a person or animal. A measurement of this presence.

External analysis
Where a cohort is compared to the general population (i.e. a population external to the cohort)

Frequency
In statistics – frequency is the recorded or expected number of occurrences of a particular type during a specified time period.

Incidence
The proportion of new cases of interest in a study population in a given period.

Internal analysis
Where subgroups within a cohort are compared with each other (i.e. the comparisons are internal to the cohort).

Mortality
Death. Usually the cause (specific disease, condition, or injury) is stated.

Person-time
A unit of measurement used in the estimation of rates that reflects the amount of time that persons were observed to be exposed to a particular risk factor. Frequently expressed in terms of "person years" (or another unit of time).

Person years
Describes the accumulated amount of time that study participants were being followed up. So, if five people were followed up for ten years each, this would be equivalent to 50 person-years of follow up. Sometimes the rate of an event in a study is given per person year rather than as a simple proportion of people affected, to take into account the fact that different people in the study may have been followed up for different lengths of time.

Population
The total set of persons, things or events under investigation or relevant to a study. If a population is large, a sample may be drawn from it and the characteristics of the population then inferred from the characteristics of the sample through use of statistics.

Power (in epidemiology and statistics)
Power is the ability of an epidemiological study to detect a true effect (or difference) of a specified size.

Prevalence
The proportion of people that have a given disease or condition at a specified point in time. Prevalence is not a rate; it is not simply a count of incident cases over a period.

P-value
The probability that an observed difference has arisen by chance alone. By convention, a P-value of 0.05 or less is usually considered statistically significant because the difference it relates to would occur by chance alone only one in twenty times or less often.

Rate
A proportion that takes the additional dimension of time, e.g. 6 new cases per thousand of population per year. Incidence is an example of a rate.

Ratio
A comparison of two numbers - the number of observations with a characteristic of interest compared with or divided by the number without that characteristic.
Relative Incidence Ratio (RIR)
Compares the cancer incidence rates for groups of firefighters

Relative Mortality Ratio (RMR)
Compares the mortality rates for groups of firefighters with the earliest, lowest or shortest duration group. This is calculated by dividing the number of deaths in that group with the number of person-years in the same group.

Risk (in statistics & epidemiology)
The probability that an event, e.g. the occurrence of a specific disease, will happen during the study period. [This is the way that the term risk is used in 'relative risk' which refers to association but not necessarily causation. However, in most situations where the term risk is used in preventive medicine, there is an implication of causation - the probability that harm will occur. Hence, risk factors.]

Sample
A relatively small set of observations or individuals drawn from a larger universe of potential observations or individuals. The sample is usually assumed to have all the essential characteristics of the larger population from which it is drawn, but this does not always happen in practice.

Selection bias
One of the major classes of bias in an epidemiological study which happens when there is a difference between the characteristics of the people selected for the study and the characteristics of those who were not selected.

Sensitivity and Specificity
Sensitivity: the probability that a person who actually has the disease of interest will have a positive (abnormal) test result.
Specificity: The probability that a person who actually does not have the disease will have a negative (normal) test result.

Significance level
This refers to the probability that chance is the explanation of a difference between means, proportions or counts; it provides the means of decision-making once a statistical test of significance is underway. It is simply an arbitrary level of probability, usually 0.05, below which chance is rejected as the explanation of difference, i.e. it is the level at which the null hypothesis is rejected in favour of the alternative hypothesis.

Standardise
Alter in a way that enables fair and ready comparison with a recognised model.

Standardisation
A change to findings to make them more readily comparable with others that refer to similar things.

Standardised Incidence Ratio (SIR)
Compares the cohort data with the Australian population.

Standardised Mortality Ratio (SMR)
Compares the actual number of deaths from a particular cause in the cohort with the expected number of deaths in the cohort if the death rate in the cohort was the same as that of the Australian population.

Statistically significant
'Not likely to happen just by chance'. The phrase 'not likely' is made more exact by setting a level of probability below which we reject chance as the explanation. This arbitrary level is designated 'a'; it is most commonly set at 0.05. This means that if:
- the P-value is less than 0.05, or
- the 95% [1] confidence interval of a ratio does not include the value 1, or
- the 95% confidence interval of a difference does not include 0, then chance can be rejected as the explanation of why one group differs from another.
[1] 95% is the same as or 0.95 which is 1 – a.

Tertile
A group derived by ranking the population according to specified criteria and dividing it into three equal parts

Trend
A long-term movement or change in frequency, usually upwards or downwards.

Abbreviations

95%CI	95% Confidence Interval
ABS	Australian Bureau of Statistics
ACS	Automated Coding System used by ABS to code deaths
ACT	Australian Capital Territory
ACTFR	Australian Capital Territory Fire and Rescue
AFAC	Australasian Fire and Emergency Service Authorities Council
AIHW	Australian Institute of Health and Welfare
ASA	Air Services Australia
BA	Breathing Apparatus supplying clean air
CFA	Country Fire Authority
DFESWA	Department of Fire and Emergency Services Western Australia
E	Expected
FBEU	Fire Brigade Employees Union
FRNSW	Fire and Rescue New South Wales
HAZMAT	Hazardous Materials Incidents
HR	Human resources
HREC	Human Research Ethics Committees
HWE	Healthy Worker Effect
IARC	International Agency for Research on Cancer
ICD-10	International Classification of Disease Version 10
ICD-9	International Classification of Disease Version 9
IHD	Ischaemic heat disease
LH	Lympho-haematopoetic
MDS	Myelodysplastic Syndrome
MFB	Metropolitan Fire and Emergency Services Victoria
mIE	meta-incidence estimate
MM	Multiple myeloma
MonCOEH	Monash University Centre for Occupational and Environmental Health
MUHREC	Monash University Human Research Ethics Committee
NCIS	National Coronial Information Service
NHL	Non-Hodgkin lymphoma
NHMRC	National Health and Medical Research Council
NSW	New South Wales
NSWRFS	New South Wales Rural Fire Service
NTFRS	Northern Territory Fire and Rescue Service
O	Observed
PAHs	Polycyclic Aromatic Hydrocarbons
QFES	Queensland Fire and Emergency Service
RIR	Relative Incidence Ratio
RMR	Relative Mortality Ratio
RMS	CFA computerised HR system
RO	Regional Officers
RPE	Respiratory protective equipment includes air supplied BA & filtering face masks
SIR	Standardised Incidence Ratio
SMOR	Standardised Morbidity Odds Ratio
SMR	Standardised Mortality Ratio
SRE	Summary Risk Estimate
TRG	Technical Reference Group
UFUA	United Firefighters Union of Australia
US	United States
UV	United Voice
VFBV	Volunteer Fire Brigades Victoria

Appendix 1 Data Items Requested from Agencies

The following data items were obtained

1. A data set containing personal information including (where available):

- Agency ID or registration number
- Surname
- First name
- Middle name (if available)
- Preferred name (if available)
- Date of birth
- Sex
- Last known residential postcode
- Live status (any death notification)
- Other jobs (if known)

2. A data set containing service history information for all employees or volunteer members including (where available):

- Agency ID or registration number
- Occupational status (e.g. permanent, part-time, exchange, volunteer, temporary)
- Job /position code
- Job /position title
- Job start date
- Job end date
- Job location
- Platoon/ Area
- Additional job code/title/dates/location/platoon data relevant to position changes over time

3. A dataset containing incident attendance information for all employees or volunteer members from the incident database including (where available):

- Agency ID or registration number
- Surname
- Date of Birth
- Incident number
- Incident date
- Incident type
- Arrival date
- Arrival time
- Return to service date
- Return to service time
- Primary action
- BA worn by the individual (Yes/No)
- Number of brigade personnel injured
- Number of other persons injured
- Number of brigade personnel fatalities
- Number of other fatalities
- Type of Hazardous Material incident
- United Nations (UN) number
- Chemical name
- Trade name
- State of substance
- Quantity released
- Primary action taken
- Primary respiratory protection
- Protective Clothing

Appendix 2 Data Handling and Cleaning Processes

The data were loaded into a study database which has two components, the front end and back end. The back end contains all the data which was stored in an SQL Server database on a secure Monash University server. A comprehensive data dictionary was prepared and stored with this database. Identifiers such as names and dates of birth were kept separate from the de-identified data set, which contains details of causes of death and cancer diagnoses. The records were linked by a common study-specific identification number (Fire-ID). Analysis was undertaken on a de-identified data set.

The front end was written in Microsoft Access and access to the data was limited only to MonCOEH staff working on the study and constituted a password login with user access and data modification rights controlled by the MonCOEH data manager.

The data were checked for completeness by the research team before being collated and passed to the AIHW for linkage.

The date of last contact for individual cohort members was the date when the data set was sent from the agency for current employees or current volunteer firefighters, or the date when the employee/volunteer resigned for former firefighters. Where no job history was provided, the date when the relevant HR data system commenced was used as the date of last contact.

Each original data set was archived unchanged and a copy was loaded into the study database and the following cleaning procedures carried out to produce the final data set. At each step, clarification was sought from the agency where there was missing or conflicting information.

- Duplicates were merged
- Missing or implausible birth dates and employment/voluntary service start and end dates or other missing data were followed up with the agency, checked and confirmed.
- Each cohort member was assigned to one of the three groups (ever career full-time firefighter, ever part-time paid firefighter (includes auxiliary and retained designations) but never full-time firefighter, or only ever volunteer firefighter.
- Employee records with no job history were sent back to the agency to see if a job history can be extracted. An initial start date of employment/ voluntary service was required to be included in the cohort at the very minimum, because without it was not possible to work out a date of last contact or if a cancer occurred before or after employment/ voluntary service commenced.

Appendix 3 Analysis Methodology

There are two main ways to analyse the cohort data these are summarised below [60]:

1. The Standardised Mortality Ratio and
2. Standardised Incidence Ratio which compare the cohort data with the Australian population.

The Standardised Mortality Ratio (SMR) compares the actual number of deaths from a particular cause in the cohort with the expected number of deaths in the cohort if the death rate in the cohort was the same as that of the Australian population. To find the expected number of deaths, the numbers of person-years were calculated in the cohort grouped by age group and calendar time, and project the Australian death rates to this population. The actual number of deaths was divided by the expected number of deaths to calculate the SMR. If the death rate in the cohort is the same as that of the Australian population, the SMR is equal to 1 (sometimes reported as a percentage i.e. 100). If the SMR is greater than 1 then the death rate in the cohort is greater than that of the Australian population. The same calculations can be done for incident cancers as a group and for individual cancers of interest, to calculate a Standardised Incidence Ratio (SIR).

The Relative Mortality Ratio (RMR) compares the mortality rates for groups of firefighters with the earliest, lowest or shortest duration group. This is calculated by dividing the number of deaths in that group with the number of person-years in the same group. The rate ratio for each of the other groups is calculated as the rate in each group divided by the rate in the comparison group. A rate ratio of 1 indicates that the exposed group has the same rate of death as the comparison group. Similar calculations will be made for incident cancers. The Relative Incidence Ratio (RIR) compares the cancer incidence rates for groups of firefighters. Such internal comparisons can only be done where there are sufficient numbers in the groups being compared. The big advantage of doing internal comparisons is that it helps to overcome the healthy worker effect. Firefighters, as a group, can be expected to be fitter when they are taken into a fire agency, than the majority of the Australian community.

The SMR and SIR will be accompanied by 95% confidence intervals. If the confidence intervals do not include one, the risk will be considered statistically significantly increased or decreased.

Appendix 4 Incident Data Used in the Study by Agency

Agency	Start date of data*	All Incident Count	All Fire Count	All Structural Count	All Landscape Count	All Vehicle Count
CFA career	01/01/1998	351,136	131,258	44,067	37,823	19,460
CFA volunteer	01/01/1998	469,438	189,299	58,101	68,347	26,618
DFESWA career	01/01/2000	165,321	80,965	18,414	47,223	11,820
DFESWA volunteer	01/01/2000	57,573	36,887	6,559	25,172	3,884
FRNSW	01/01/2000	568,794	430,682	101,969	143,089	65,133
MFB	01/01/1990	365,925	199,131	87,363	38,847	30,160
NSWRFSǂ	01/0/1/2001	-	-	-	-	-
NTFRS career	01/01/2000	32,895	19,453	2,124	16,536	1,715
NTFRS volunteer	01/01/2000	1,563	729	69	608	26
QFES career	01/01/2000	568,336	139,796	30,010	67,402	17943

* Year that incident data assumed by Monash to be complete for individuals

ǂ For NSWRFS the number of incidents attended by an individual was recorded but Monash was not provided with a unique incident identifier. More than one individual would attend most incidents, the number of unique incidents cannot be identified for this table.

Appendix 5 Tables by Age, Service Duration and Era

Table 18: Standardised Mortality Ratios* and 95% confidence intervals for male career full-time firefighter deaths to 30/11/2011 by age group compared to the Australian population

Cause of Death Categories	<65 years			65+ years		
	O	E	SMR (95%CI)	O	E	SMR (95%CI)
All Causes of Death Combined	**439**	**759.54**	**0.58 (0.53 - 0.63)**	**341**	**410.41**	**0.83 (0.75 - 0.92)**
All Malignancies	**182**	**248.08**	**0.73 (0.63 - 0.85)**	147	159.70	0.92 (0.78 - 1.08)
All Nervous System	**5**	**17.77**	**0.28 (0.09 - 0.66)**	15	12.42	1.21 (0.68 - 1.99)
All Circulatory	**106**	**192.96**	**0.55 (0.45 - 0.66)**	**103**	**134.78**	**0.76 (0.62 - 0.93)**
Hypertensive	2	3.09	0.65 (0.08 - 2.34)	3	2.86	1.05 (0.22 - 3.07)
Ischaemic Heart Disease	**80**	**130.34**	**0.61 (0.49 - 0.76)**	70	80.22	0.87 (0.68 - 1.10)
Cerebrovascular	**10**	**24.25**	**0.41 (0.20 - 0.76)**	17	25.81	0.66 (0.38 - 1.05)
All Respiratory	**12**	**28.27**	**0.42 (0.22 - 0.74)**	26	37.33	0.70 (0.45 - 1.02)
COPD	**4**	**13.13**	**0.30 (0.08 - 0.78)**	18	22.66	0.79 (0.47 - 1.26)
All Digestive	**19**	**36.88**	**0.52 (0.31 - 0.80)**	11	12.56	0.88 (0.44 - 1.57)
Diseases of the Liver	**16**	**27.85**	**0.57 (0.33 - 0.93)**	6	4.96	1.21 (0.44 - 2.63)
All Injury & Trauma	**82**	**160.57**	**0.51 (0.41 - 0.63)**	6	11.48	0.52 (0.19 - 1.14)
All Accidents	**32**	**83.75**	**0.38 (0.26 - 0.54)**	3	7.63	0.39 (0.08 - 1.15)
Fire	1	1.90	0.53 (0.01 - 2.93)	0	0.18	-
Suicide	**48**	**64.36**	**0.75 (0.55 - 0.99)**	2	2.85	0.70 (0.09 - 2.54)
All Other Causes	**31**	**75.01**	**0.41 (0.28 - 0.59)**	32	42.13	0.76 (0.52 - 1.07)
Dementia & Alzheimers	1	1.33	0.75 (0.02 - 4.20)	8	9.28	0.86 (0.37 - 1.70)
Diabetes	10	14.27	0.70 (0.34 - 1.29)	13	12.39	1.05 (0.56 - 1.79)

* Statistically significantly reduced SMR results are in **blue**

Table 19: Standardised Mortality Ratios* and 95% confidence intervals for male part-time paid firefighter deaths to 30/11/2011 by age group compared to the Australian population

Cause of Death Categories	<65 years			65+ years		
	O	E	SMR (95%CI)	O	E	SMR (95%CI)
All Causes of Death Combined	**209**	**331.74**	**0.63 (0.55 - 0.72)**	**77**	**107.29**	**0.72 (0.57 - 0.90)**
All Malignancies	85	102.06	0.83 (0.67 - 1.03)	39	46.28	0.84 (0.60 - 1.15)
All Nervous System	3	8.75	0.34 (0.07 - 1.00)	1	3.30	0.30 (0.01 - 1.69)
All Circulatory	**36**	**73.39**	**0.49 (0.34 - 0.68)**	24	31.10	0.77 (0.49 - 1.15)
Hypertensive	2	1.22	1.65 (0.20 - 5.94)	1	0.65	1.53 (0.04 - 8.53)
Ischaemic Heart Disease	**26**	**47.86**	**0.54 (0.35 - 0.80)**	13	18.64	0.70 (0.37 - 1.19)
Cerebrovascular	5	9.30	0.54 (0.17 - 1.25)	4	5.67	0.71 (0.19 - 1.81)
All Respiratory	**1**	**11.01**	**0.09 (0.00 - 0.51)**	7	9.03	0.78 (0.31 - 1.60)
COPD	1	4.64	0.22 (0.01 - 1.20)	2	5.50	0.36 (0.04 - 1.31)
All Digestive	**7**	**15.51**	**0.45 (0.18 - 0.93)**	1	3.44	0.29 (0.01 - 1.62)
Diseases of the Liver	**5**	**11.84**	**0.42 (0.14 - 0.99)**	0	1.60	-
All Injury & Trauma	**65**	**86.32**	**0.75 (0.58 - 0.96)**	3	3.22	0.93 (0.19 - 2.72)
All Accidents	39	44.17	0.88 (0.63 - 1.21)	3	2.03	1.48 (0.31 - 4.33)
Fire	1	0.85	1.17 (0.03 - 6.54)	1	0.05	20.68 (0.52 - 115.2)
Suicide	**22**	**35.21**	**0.62 (0.39 - 0.95)**	0	0.88	-
All Other Causes	**12**	**34.71**	**0.35 (0.18 - 0.60)**	**2**	**10.92**	**0.18 (0.02 - 0.66)**
Dementia & Alzheimers	2	0.55	3.62 (0.44 - 13.06)	0	1.94	-
Diabetes	**1**	**6.22**	**0.16 (0.00 - 0.90)**	0	3.46	-

* Statistically significantly reduced SMR results are in **blue**

Table 20: Standardised Mortality Ratios* and 95% confidence intervals for male volunteer firefighter deaths to 30/11/2011 by age group compared to the Australian population

Cause of Death Categories	<65 years			65+ years		
	O	E	SMR (95%CI)	O	E	SMR (95%CI)
All Causes of Death Combined	**2099**	**4018.10**	**0.52 (0.50 - 0.55)**	**2548**	**4658.83**	**0.55 (0.53 - 0.57)**
All Malignancies	**823**	**1441.98**	**0.57 (0.53 - 0.61)**	**1077**	**1760.96**	**0.61 (0.58 - 0.65)**
All Nervous System	**46**	**108.72**	**0.42 (0.31 - 0.56)**	**75**	**157.93**	**0.47 (0.37 - 0.60)**
All Circulatory	**436**	**938.13**	**0.46 (0.42 - 0.51)**	**814**	**1492.86**	**0.55 (0.51 - 0.58)**
Hypertensive	**8**	**15.86**	**0.50 (0.22 - 0.99)**	**23**	**35.05**	**0.66 (0.42 - 0.98)**
Ischaemic Heart Disease	**270**	**615.04**	**0.44 (0.39 - 0.49)**	**448**	**847.42**	**0.53 (0.48 - 0.58)**
Cerebrovascular	**50**	**118.98**	**0.42 (0.31 - 0.55)**	**139**	**305.77**	**0.45 (0.38 - 0.54)**
All Respiratory	**52**	**152.59**	**0.34 (0.25 - 0.45)**	**164**	**434.43**	**0.38 (0.32 - 0.44)**
COPD	**26**	**71.38**	**0.36 (0.24 - 0.53)**	**89**	**245.33**	**0.36 (0.29 - 0.45)**
All Digestive	**54**	**195.74**	**0.28 (0.21 - 0.36)**	**54**	**143.17**	**0.38 (0.28 - 0.49)**
Diseases of the Liver	**36**	**147.32**	**0.24 (0.17 - 0.34)**	**14**	**51.08**	**0.27 (0.15 - 0.46)**
All Injury & Trauma	**556**	**792.71**	**0.70 (0.64 - 0.76)**	**107**	**134.10**	**0.80 (0.65 - 0.96)**
All Accidents	**325**	**415.04**	**0.78 (0.70 - 0.87)**	80	92.63	0.86 (0.68 - 1.07)
Fire	16	8.49	1.89 (1.08 - 3.06)	3	1.88	1.59 (0.33 - 4.66)
Suicide	**189**	**311.64**	**0.61 (0.52 - 0.70)**	**15**	**29.07**	**0.52 (0.29 - 0.85)**
All Other Causes	**126**	**388.23**	**0.32 (0.27 - 0.39)**	**253**	**535.39**	**0.47 (0.42 - 0.53)**
Dementia & Alzheimers	**3**	**10.23**	**0.29 (0.06 - 0.86)**	**54**	**137.46**	**0.39 (0.30 - 0.51)**
Diabetes	**19**	**86.79**	**0.22 (0.13 - 0.34)**	**67**	**146.03**	**0.46 (0.36 - 0.58)**

* Statistically significantly reduced SMR results are in **blue**

Table 21: Standardised Mortality Ratios* and 95% confidence intervals for female volunteer firefighter deaths to 30/11/2011 by age group compared to the Australian population

Cause of Death Categories	<65 years			65+ years		
	O	E	SMR (95%CI)	O	E	SMR (95%CI)
All Causes of Death Combined	**280**	**439.75**	**0.64 (0.56 - 0.72)**	**246**	**383.18**	**0.64 (0.56 - 0.73)**
All Malignancies	**151**	**225.97**	**0.67 (0.57 - 0.78)**	117	133.16	0.88 (0.73 - 1.05)
All Nervous System	**2**	**15.36**	**0.13 (0.02 - 0.47)**	9	16.41	0.55 (0.25 - 1.04)
All Circulatory	**40**	**63.30**	**0.63 (0.45 - 0.86)**	**60**	**120.87**	**0.50 (0.38 - 0.64)**
Hypertensive	1	1.56	0.64 (0.02 - 3.57)	1	4.70	0.21 (0.01 - 1.19)
Ischaemic Heart Disease	**13**	**26.51**	**0.49 (0.26 - 0.84)**	**24**	**54.34**	**0.44 (0.28 - 0.66)**
Cerebrovascular	11	16.29	0.68 (0.34 - 1.21)	**13**	**33.38**	**0.39 (0.21 - 0.67)**
All Respiratory	**6**	**22.11**	**0.27 (0.10 - 0.59)**	**15**	**33.95**	**0.44 (0.25 - 0.73)**
COPD	**3**	**10.68**	**0.28 (0.06 - 0.82)**	**8**	**18.02**	**0.44 (0.19 - 0.87)**
All Digestive	**5**	**16.83**	**0.30 (0.10 - 0.69)**	10	13.08	0.76 (0.37 - 1.41)
Diseases of the Liver	**3**	**10.86**	**0.28 (0.06 - 0.81)**	2	2.89	0.69 (0.08 - 2.50)
All Injury & Trauma	55	52.03	1.06 (0.80 - 1.38)	11	9.79	1.12 (0.56 - 2.01)
All Accidents	**39**	**27.54**	**1.42 (1.01 - 1.94)**	8	7.57	1.06 (0.46 - 2.08)
Fire	1	1.69	0.59 (0.01 - 3.30)	1	0.24	4.14 (0.10 - 23.07)
Suicide	14	18.03	0.78 (0.42 - 1.30)	0	1.03	-
All Other Causes	**21**	**44.16**	**0.48 (0.29 - 0.73)**	**23**	**55.91**	**0.41 (0.26 - 0.62)**
Dementia & Alzheimers	1	1.89	0.53 (0.01 - 2.95)	12	17.82	0.67 (0.35 - 1.18)
Diabetes	4	8.72	0.46 (0.13 - 1.18)	7	12.24	0.57 (0.23 - 1.18)

* Statistically significantly elevated SMR results are in **red**, statistically significantly reduced SIR results are in **blue**

Table 22: Standardised Cancer Incidence Ratios* and 95% confidence intervals for male career full-time firefighters to 31/12/2010 by age group compared to the Australian population

Cancer Categories	<65 years			65+ years		
	O	E	SIR (95%CI)	O	E	SIR (95%CI)
All Malignancies	835	787.24	1.06 (0.99 - 1.14)	**373**	**333.79**	**1.12 (1.01 - 1.24)**
Lip, Oral Cavity & Pharynx	41	48.94	0.84 (0.60 - 1.14)	14	9.17	1.53 (0.83 - 2.56)
Lip	18	17.84	1.01 (0.60 - 1.59)	5	2.90	1.72 (0.56 - 4.03)
Digestive Organs	144	156.77	0.92 (0.77 - 1.08)	86	73.3	1.17 (0.94 - 1.45)
Oesophagus	6	10.90	0.55 (0.20 - 1.20)	6	4.88	1.23 (0.45 - 2.67)
Stomach	13	16.69	0.78 (0.41 - 1.33)	11	7.85	1.40 (0.70 - 2.51)
Colorectal	105	98.07	1.07 (0.88 - 1.30)	52	46.58	1.12 (0.83 - 1.46)
Colon	59	52.97	1.11 (0.85 - 1.44)	33	28.51	1.16 (0.80 - 1.63)
Rectum	38	33.51	1.13 (0.80 - 1.56)	17	12.92	1.32 (0.77 - 2.11)
Liver	**3**	**11.11**	**0.27 (0.06 - 0.79)**	5	4.22	1.18 (0.38 - 2.76)
Pancreas	13	13.54	0.96 (0.51 - 1.64)	9	7.02	1.28 (0.59 - 2.43)
Respiratory	**58**	**77.90**	**0.74 (0.57 - 0.96)**	42	45.05	0.93 (0.67 - 1.26)
Larynx	9	9.43	0.95 (0.44 - 1.81)	2	3.31	0.60 (0.07 - 2.18)
Lung	**47**	**65.54**	**0.72 (0.53 - 0.95)**	39	41.03	0.95 (0.68 - 1.30)
Melanoma	**167**	**118.68**	**1.41 (1.20 - 1.64)**	**42**	**25.63**	**1.64 (1.18 - 2.22)**
Mesothelioma	10	4.86	2.06 (0.99 - 3.78)	1	3.44	0.29 (0.01 - 1.62)
Male Reproductive	**233**	**188.05**	**1.24 (1.09 - 1.41)**	124	110.10	1.13 (0.94 - 1.34)
Prostate	**202**	**162.38**	**1.24 (1.08 - 1.43)**	**123**	**101.56**	**1.21 (1.01 - 1.45)**
Testis	31	21.30	1.46 (0.99 - 2.07)	0	0.18	-
Urinary tract	40	44.95	0.89 (0.64 - 1.21)	19	19.96	0.95 (0.57 - 1.49)
Kidney	24	26.60	0.90 (0.58 - 1.34)	9	7.50	1.20 (0.55 - 2.28)
Bladder	14	16.19	0.86 (0.47 - 1.45)	9	10.95	0.82 (0.38 - 1.56)
Brain & Other CNS	14	18.29	0.77 (0.42 - 1.28)	3	3.60	0.83 (0.17 - 2.44)
Brain	13	17.47	0.74 (0.40 - 1.27)	3	3.49	0.86 (0.18 - 2.51)

Cancer Categories	<65 years			65+ years		
	O	E	SIR (95%CI)	O	E	SIR (95%CI)
Thyroid & Other Endocrine	11	10.82	1.02 (0.51 - 1.82)	2	1.22	1.64 (0.20 - 5.91)
Thyroid	11	9.95	1.11 (0.55 - 1.98)	2	1.10	1.82 (0.22 - 6.58)
Unknown Site	16	18.02	0.89 (0.51 - 1.44)	11	9.270	1.19 (0.59 - 2.12)
Lympho-haematopoetic	84	84.22	1.00 (0.80 - 1.23)	25	30.03	0.83 (0.54 - 1.23)
Hodgkin Disease	6	6.06	0.99 (0.36 - 2.16)	0	0.51	-
Non-Hodgkin Lymphoma	37	37.46	0.99 (0.70 - 1.36)	10	10.58	0.95 (0.45 - 1.74)
Follicular-NHL	13	10.10	1.29 (0.69 - 2.20)	3	1.91	1.57 (0.32 - 4.60)
Diffuse-NHL	17	17.30	0.98 (0.57 - 1.57)	5	5.35	0.93 (0.30 - 2.18)
Myeloma	10	8.91	1.12 (0.54 - 2.06)	5	4.20	1.19 (0.39 - 2.78)
Leukaemia	23	22.18	1.04 (0.66 - 1.56)	5	8.34	0.60 (0.19 - 1.40)
MDS	2	1.63	1.22 (0.15 - 4.42)	2	2.76	0.72 (0.09 - 2.61)
All Other Cancers	17	15.73	1.08 (0.63 - 1.73)	4	3.03	1.32 (0.36 - 3.38)
Male Breast	3	1.43	2.10 (0.43 - 6.15)	2	0.58	3.45 (0.42 - 12.45)

* Statistically significantly elevated SIR results are in **red**, statistically significantly reduced SIR results are in **blue**

Table 23: Standardised Cancer Incidence Ratios* and 95% confidence intervals for male part-time paid firefighters by age to 31/12/2010 compared to the Australian population

Cancer Categories	<65 years			65+ years		
	O	E	SIR (95%CI)	O	E	SIR (95%CI)
All Malignancies	375	341.96	1.10 (0.99 - 1.21)	110	96.87	1.14 (0.93 - 1.37)
Lip, Oral Cavity & Pharynx	18	20.96	0.86 (0.51 - 1.36)	3	2.62	1.15 (0.24 - 3.35)
Lip	11	7.89	1.39 (0.70 - 2.49)	0	0.77	-
Digestive Organs	66	64.76	1.02 (0.79 - 1.30)	19	20.91	0.91 (0.55 - 1.42)
Oesophagus	2	4.52	0.44 (0.05 - 1.60)	3	1.37	2.19 (0.45 - 6.39)
Stomach	8	6.62	1.21 (0.52 - 2.38)	1	2.10	0.48 (0.01 - 2.65)
Colorectal	45	40.30	1.12 (0.81 - 1.49)	12	13.44	0.89 (0.46 - 1.56)
Colon	22	21.42	1.03 (0.64 - 1.55)	5	8.18	0.61 (0.20 - 1.43)
Rectum	16	14.02	1.14 (0.65 - 1.85)	5	3.80	1.32 (0.43 - 3.07)
Liver	3	4.97	0.60 (0.12 - 1.77)	1	1.27	0.79 (0.02 - 4.40)
Pancreas	5	5.59	0.89 (0.29 - 2.09)	2	1.97	1.01 (0.12 - 3.66)
Respiratory	**15**	**29.35**	**0.51 (0.29 - 0.84)**	**2**	**12.33**	**0.16 (0.02 - 0.59)**
Larynx	1	3.48	0.29 (0.01 - 1.60)	0	0.94	-
Lung	**13**	**24.55**	**0.53 (0.28 - 0.91)**	**2**	**11.19**	**0.18 (0.02 - 0.65)**
Melanoma	**75**	**54.82**	**1.37 (1.08 - 1.72)**	**14**	**7.56**	**1.85 (1.01 - 3.11)**
Mesothelioma	3	1.90	1.57 (0.32 - 4.60)	1	1.00	1.00 (0.03 - 5.56)
Male Reproductive	**118**	**84.84**	**1.39 (1.15 - 1.67)**	**49**	**33.94**	**1.44 (1.07 - 1.91)**
Prostate	**104**	**69.83**	**1.49 (1.22 - 1.80)**	**49**	**31.18**	**1.57 (1.16 - 2.08)**
Testis	12	12.81	0.94 (0.48 - 1.64)	0	0.05	-
Urinary tract	18	18.66	0.96 (0.57 - 1.52)	7	5.41	1.29 (0.52 - 2.67)
Kidney	15	11.90	1.26 (0.71 - 2.08)	4	2.23	1.79 (0.49 - 4.59)
Bladder	3	5.93	0.51 (0.10 - 1.48)	2	2.78	0.72 (0.09 - 2.60)
Brain & Other CNS	11	8.41	1.31 (0.65 - 2.34)	2	1.07	1.87 (0.23 - 6.77)
Brain	10	8.02	1.25 (0.60 - 2.29)	2	1.04	1.93 (0.23 - 6.97)
Thyroid & Other Endocrine	4	5.64	0.71 (0.19 - 1.82)	**3**	**0.39**	**7.62 (1.57 - 22.26)**
Thyroid	4	5.21	0.77 (0.21 - 1.97)	**3**	**0.36**	**8.45 (1.74 - 24.69)**

Cancer Categories	<65 years			65+ years		
	O	E	SIR (95%CI)	O	E	SIR (95%CI)
Unknown Site	5	7.01	0.71 (0.23 - 1.66)	1	2.30	0.43 (0.01 - 2.42)
Lympho-haematopoetic	35	38.69	0.90 (0.63 - 1.26)	8	8.48	0.94 (0.41 - 1.86)
Hodgkin Disease	4	3.37	1.19 (0.32 - 3.04)	0	0.15	-
Non-Hodgkin Lymphoma	16	16.87	0.95 (0.54 - 1.54)	3	3.06	0.98 (0.20 - 2.87)
Follicular-NHL	6	4.59	1.31 (0.48 - 2.84)	1	0.60	1.67 (0.04 - 9.31)
Diffuse-NHL	7	7.85	0.89 (0.36 - 1.84)	2	1.54	1.30 (0.16 - 4.69)
Myeloma	1	3.75	0.27 (0.01 - 1.49)	2	1.19	1.68 (0.20 - 6.08)
Leukaemia	12	10.09	1.19 (0.61 - 2.08)	3	2.31	1.30 (0.27 - 3.80)
MDS	0	0.79	-	0	0.81	-
All Other Cancers	7	6.93	1.01 (0.41 - 2.08)	1	0.86	1.17 (0.03 - 6.51)
Male Breast	1	0.59	1.68 (0.04 - 9.38)	0	0.17	-

* Statistically significantly elevated SIR results are in **red**, statistically significantly reduced SIR results are in **blue**

Table 24: Standardised Cancer Incidence Ratios* and 95% confidence intervals for male volunteer firefighters to 31/12/2010 by age group compared to the Australian population

Cancer Categories	<65 years			65+ years		
	O	E	SIR (95%CI)	O	E	SIR (95%CI)
All Malignancies	**4196**	**4789.21**	**0.88 (0.85 - 0.90)**	**2861**	**3426.97**	**0.83 (0.80 - 0.87)**
Lip, Oral Cavity & Pharynx	**176**	**255.92**	**0.69 (0.59 - 0.80)**	69	86.87	0.79 (0.62 - 1.01)
Lip	85	81.98	1.04 (0.83 - 1.28)	40	26.70	1.50 (1.07 - 2.04)
Digestive Organs	**749**	**931.34**	**0.80 (0.75 - 0.86)**	**548**	**747.94**	**0.73 (0.67 - 0.80)**
Oesophagus	**46**	**67.82**	**0.68 (0.50 - 0.90)**	**31**	**49.81**	**0.62 (0.42 - 0.88)**
Stomach	**66**	**89.69**	**0.74 (0.57 - 0.94)**	**50**	**77.29**	**0.65 (0.48 - 0.85)**
Colorectal	**512**	**577.57**	**0.89 (0.81 - 0.97)**	**385**	**475.05**	**0.81 (0.73 - 0.90)**
Colon	278	307.06	0.91 (0.80 - 1.02)	**248**	**296.85**	**0.84 (0.73 - 0.95)**
Rectum	190	203.22	0.93 (0.81 - 1.08)	111	131.26	0.85 (0.70 - 1.02)
Liver	**28**	**73.82**	**0.38 (0.25 - 0.55)**	**11**	**44.79**	**0.25 (0.12 - 0.44)**
Pancreas	**63**	**83.48**	**0.75 (0.58 - 0.97)**	**53**	**73.18**	**0.72 (0.54 - 0.95)**
Respiratory	**221**	**429.29**	**0.51 (0.45 - 0.59)**	**208**	**440.45**	**0.47 (0.41 - 0.54)**
Larynx	**23**	**49.70**	**0.46 (0.29 - 0.69)**	**13**	**31.04**	**0.42 (0.22 - 0.72)**
Lung	**182**	**364.00**	**0.50 (0.43 - 0.58)**	**189**	**402.31**	**0.47 (0.41 - 0.54)**
Melanoma	680	645.80	1.05 (0.98 - 1.14)	**232**	**270.35**	**0.86 (0.75 - 0.98)**
Mesothelioma	25	28.74	0.87 (0.56 - 1.28)	**17**	**36.43**	**0.47 (0.27 - 0.75)**
Male Reproductive	**1503**	**1413.60**	**1.06 (1.01 - 1.12)**	**1260**	**1150.57**	**1.10 (1.04 - 1.16)**
Prostate	**1403**	**1280.32**	**1.10 (1.04 - 1.15)**	**1252**	**1087.96**	**1.15 (1.09 - 1.22)**
Testis	95	105.44	0.90 (0.73 - 1.10)	4	1.70	2.35 (0.64 - 6.02)
Urinary tract	**182**	**259.32**	**0.70 (0.60 - 0.81)**	**152**	**202.16**	**0.75 (0.64 - 0.88)**
Kidney	**122**	**162.69**	**0.75 (0.62 - 0.90)**	74	77.28	0.96 (0.75 - 1.20)
Bladder	**53**	**85.20**	**0.62 (0.47 - 0.81)**	**64**	**110.03**	**0.58 (0.45 - 0.74)**
Brain & Other CNS	79	98.44	0.80 (0.64 - 1.00)	37	35.98	1.03 (0.72 - 1.42)
Brain	77	94.40	0.82 (0.64 - 1.02)	37	34.86	1.06 (0.75 - 1.46)

Cancer Categories	<65 years			65+ years		
	O	E	SIR (95%CI)	O	E	SIR (95%CI)
Thyroid & Other Endocrine	53	63.21	0.84 (0.63 - 1.10)	9	13.04	0.69 (0.32 - 1.31)
Thyroid	49	58.53	0.84 (0.62 - 1.11)	9	11.77	0.76 (0.35 - 1.45)
Unknown Site	**50**	**92.82**	**0.54 (0.40 - 0.71)**	**51**	**91.43**	**0.56 (0.42 - 0.73)**
Lympho-haematopoetic	**417**	**495.91**	**0.84 (0.76 - 0.93)**	**246**	**321.09**	**0.77 (0.67 - 0.87)**
Hodgkin Disease	29	33.58	0.86 (0.58 - 1.24)	4	5.08	0.79 (0.21 - 2.02)
Non-Hodgkin Lymphoma	**180**	**211.39**	**0.85 (0.73 - 0.99)**	**87**	**110.15**	**0.79 (0.63 - 0.97)**
Follicular-NHL	56	59.16	0.95 (0.72 - 1.23)	18	19.94	0.90 (0.54 - 1.43)
Diffuse-NHL	83	97.47	0.85 (0.68 - 1.06)	43	55.63	0.77 (0.56 - 1.04)
Myeloma	42	55.06	0.76 (0.55 - 1.03)	32	44.08	0.73 (0.50 - 1.02)
Leukaemia	114	129.65	0.88 (0.73 - 1.06)	80	86.87	0.92 (0.73 - 1.15)
MDS	15	14.93	1.00 (0.56 - 1.66)	27	36.81	0.73 (0.48 - 1.07)
All Other Cancers	61	74.82	0.82 (0.62 - 1.05)	32	30.65	1.04 (0.71 - 1.47)
Male Breast	7	8.39	0.83 (0.34 - 1.72)	5	6.07	0.82 (0.27 - 1.92)

* Statistically significantly elevated SIR results are in **red**, statistically significantly reduced SIR results are in **blue**

Table 25: Standardised Cancer Incidence Ratios* and 95% confidence intervals for female volunteer firefighters to 31/12/2010 by age group compared to the Australian population

Cancer Categories	<65 years			65+ years		
	O	E	SIR (95%CI)	O	E	SIR (95%CI))
All Malignancies	799	830.97	0.96 (0.90 - 1.03)	228	230.27	0.99 (0.87 - 1.13)
Lip, Oral Cavity & Pharynx	13	15.39	0.84 (0.45 - 1.44)	3	4.31	0.70 (0.14 - 2.03)
Lip	5	3.81	1.31 (0.43 - 3.06)	1	1.28	0.78 (0.02 - 4.35)
Digestive Organs	97	107.23	0.90 (0.73 - 1.10)	66	57.65	1.14 (0.89 - 1.46)
Oesophagus	1	3.04	0.33 (0.01 - 1.83)	3	2.35	1.28 (0.26 - 3.73)
Stomach	4	7.84	0.51 (0.14 - 1.31)	0	3.84	-
Colorectal	79	76.83	1.03 (0.81 - 1.28)	52	39.28	1.32 (0.99 - 1.74)
Colon	45	46.18	0.97 (0.71 - 1.30)	36	28.00	1.29 (0.90 - 1.78)
Rectum	25	20.60	1.21 (0.79 - 1.79)	13	7.60	1.71 (0.91 - 2.93)
Liver	0	3.81	-	1	1.95	0.51 (0.01 - 2.86)
Pancreas	7	9.85	0.71 (0.29 - 1.46)	6	7.03	0.85 (0.31 - 1.86)
Respiratory	39	47.73	0.82 (0.58 - 1.12)	27	25.59	1.06 (0.70 - 1.54)
Larynx	0	0.92	-	0	0.45	-
Lung	38	45.17	0.84 (0.60 - 1.15)	27	24.75	1.09 (0.72 - 1.59)
Melanoma	**129**	**101.11**	**1.28 (1.07 - 1.52)**	18	16.96	1.06 (0.63 - 1.68)
Mesothelioma	2	1.38	1.45 (0.18 - 5.24)	1	0.66	1.51 (0.04 - 8.40)
Breast	305	310.93	0.98 (0.87 - 1.10)	44	53.48	0.82 (0.60 - 1.10)
Female-Reproductive	68	89.66	0.76 (0.59 - 0.96)	20	20.61	0.97 (0.59 - 1.50)
Cervix	**9**	**20.69**	**0.43 (0.20 - 0.83)**	3	1.82	1.65 (0.34 - 4.83)
Urinary tract	14	19.72	0.71 (0.39 - 1.19)	9	9.74	0.92 (0.42 - 1.75)
Kidney	13	14.57	0.89 (0.48 - 1.53)	6	4.78	1.26 (0.46 - 2.73)
Bladder	0	4.04	-	2	3.57	0.56 (0.07 - 2.02)
Brain & Other CNS	11	12.03	0.91 (0.46 - 1.64)	4	2.95	1.36 (0.37 - 3.47)
Brain	9	11.30	0.80 (0.36 - 1.51)	4	2.82	1.42 (0.39 - 3.63)
Thyroid & Other Endocrine	38	38.09	1.00 (0.71 - 1.37)	3	2.89	1.04 (0.21 - 3.04)
Thyroid	36	37.28	0.97 (0.68 - 1.34)	3	2.76	1.09 (0.22 - 3.18)

Cancer Categories	<65 years			65+ years		
	O	E	SIR (95%CI)	O	E	SIR (95%CI))
Unknown	8	11.78	0.68 (0.29 - 1.34)	7	7.74	0.90 (0.36 - 1.86)
Lympho-haematopoetic	69	65.73	1.05 (0.82 - 1.33)	21	25.02	0.84 (0.52 - 1.28)
Hodgkin Disease	6	5.55	1.08 (0.40 - 2.35)	2	0.44	4.58 (0.55 - 16.53)
Non-Hodgkin Lymphoma	33	27.96	1.18 (0.81 - 1.66)	5	9.86	0.51 (0.16 - 1.18)
Follicular-NHL	2	2.22	0.90 (0.11 - 3.26)	1	2.33	0.43 (0.01 - 2.39)
Diffuse-NHL	11	9.16	1.20 (0.60 - 2.15)	3	2.12	1.41 (0.29 - 4.13)
Myeloma	9	6.63	1.36 (0.62 - 2.58)	4	3.63	1.10 (0.30 - 2.82)
Leukaemia	15	15.26	0.98 (0.55 - 1.62)	8	5.67	1.41 (0.61 - 2.78)
MDS	14	10.97	1.28 (0.70 - 2.14)	1	4.70	0.21 (0.01 - 1.19)
All Other Cancers	6	10.18	0.59 (0.22 - 1.28)	5	2.67	1.87 (0.61 - 4.37)

* Statistically significantly elevated SIR results are in **red**, statistically significantly reduced SIR results are in **blue**

Table 26: Standardised Mortality Ratios* and 95% confidence intervals for male career full-time firefighter deaths to 30/11/2011 by duration of employment compared to the Australian population

Cause of Death Categories	> 3 months to 10 years			10 to 20 years			20+ years		
	O	E	SMR (95%CI)	O	E	SMR (95%CI)	O	E	SMR (95%CI)
All Causes of Death Combined	**81**	**160.23**	**0.51 (0.40 - 0.63)**	**112**	**195.70**	**0.57 (0.47 - 0.69)**	**578**	**805.36**	**0.72 (0.66 - 0.78)**
All Malignancies	24	34.62	0.69 (0.44 - 1.03)	**39**	**56.43**	**0.69 (0.49 - 0.94)**	**263**	**314.00**	**0.84 (0.74 - 0.95)**
All Nervous System	1	4.29	0.23 (0.01 - 1.30)	1	5.07	0.20 (0.00 - 1.10)	18	20.59	0.87 (0.52 - 1.38)
All Circulatory	**16**	**26.79**	**0.60 (0.34 - 0.97)**	**27**	**47.02**	**0.57 (0.38 - 0.84)**	**164**	**252.08**	**0.65 (0.55 - 0.76)**
Hypertensive	0	0.45	-	1	0.80	1.25 (0.03 - 6.98)	4	4.66	0.86 (0.23 - 2.20)
Ischaemic Heart Disease	13	16.16	0.80 (0.43 - 1.38)	**19**	**30.50**	**0.62 (0.38 - 0.97)**	**117**	**162.72**	**0.72 (0.59 - 0.86)**
Cerebrovascular	2	3.71	0.54 (0.07 - 1.95)	3	6.50	0.46 (0.10 - 1.35)	**22**	**39.61**	**0.56 (0.35 - 0.84)**
All Respiratory	2	4.46	0.45 (0.05 - 1.62)	5	7.31	0.68 (0.22 - 1.60)	**31**	**53.53**	**0.58 (0.39 - 0.82)**
COPD	2	1.41	1.42 (0.17 - 5.13)	1	3.04	0.33 (0.01 - 1.83)	**19**	**31.21**	**0.61 (0.37 - 0.95)**
All Digestive	**1**	**5.90**	**0.17 (0.00 - 0.94)**	7	9.52	0.74 (0.30 - 1.52)	**22**	**33.63**	**0.65 (0.41 - 0.99)**
Diseases of the Liver	1	4.39	0.23 (0.01 - 1.27)	5	7.16	0.70 (0.23 - 1.63)	16	20.96	0.76 (0.44 - 1.24)
All Injury & Trauma	**30**	**65.02**	**0.46 (0.31 - 0.66)**	**26**	**48.18**	**0.54 (0.35 - 0.79)**	**28**	**56.63**	**0.49 (0.33 - 0.71)**
All Accidents	**12**	**34.91**	**0.34 (0.18 - 0.60)**	**11**	**24.33**	**0.45 (0.23 - 0.81)**	**10**	**30.96**	**0.32 (0.15 - 0.59)**
Fire	0	0.61	-	1	0.56	1.79 (0.05 - 9.95)	0	0.89	-
Suicide	17	25.14	0.68 (0.39 - 1.08)	14	20.12	0.70 (0.38 - 1.17)	17	21.08	0.81 (0.47 - 1.29)
All Other Causes	**7**	**19.15**	**0.37 (0.15 - 0.75)**	**5**	**22.17**	**0.23 (0.07 - 0.53)**	**51**	**74.91**	**0.68 (0.51 - 0.90)**
Dementia & Alzheimers	0	0.24	-	0	0.70	-	9	9.64	0.93 (0.43 - 1.77)
Diabetes	2	2.21	0.90 (0.11 - 3.27)	1	3.54	0.28 (0.01 - 1.57)	20	20.74	0.96 (0.59 - 1.49)

* Statistically significantly reduced SMR results are in **blue**

Table 27: Standardised Mortality Ratios* and 95% confidence intervals for male part-time paid firefighter deaths to 30/11/2011 by duration of employment compared to the Australian population

Cause of Death Categories	> 3 months to 10 years			10 to 20 years			20+ years		
	O	E	SMR (95%CI)	O	E	SMR (95%CI)	O	E	SMR (95%CI)
All Causes of Death Combined	103	158.87	0.65 (0.53 - 0.79)	**54**	**91.60**	**0.59 (0.44 - 0.77)**	**125**	**185.95**	**0.67 (0.56 - 0.80)**
All Malignancies	35	36.63	0.96 (0.67 - 1.33)	24	32.21	0.75 (0.48 - 1.11)	64	78.93	0.81 (0.62 - 1.04)
All Nervous System	1	4.58	0.22 (0.01 - 1.22)	2	2.42	0.83 (0.10 - 2.98)	1	4.97	0.20 (0.01 - 1.12)
All Circulatory	**13**	**28.45**	**0.46 (0.24 - 0.78)**	**8**	**22.38**	**0.36 (0.15 - 0.70)**	39	53.22	0.73 (0.52 - 1.00)
Hypertensive	0	0.48	-	1	0.39	2.56 (0.06 - 14.28)	2	0.99	2.02 (0.24 - 7.29)
Ischaemic Heart Disease	12	17.48	0.69 (0.35 - 1.20)	**6**	**14.70**	**0.41 (0.15 - 0.89)**	**21**	**34.05**	**0.62 (0.38 - 0.94)**
Cerebrovascular	1	3.71	0.27 (0.01 - 1.50)	0	2.93	-	8	8.27	0.97 (0.42 - 1.91)
All Respiratory	1	4.28	0.23 (0.01 - 1.30)	1	3.58	0.28 (0.01 - 1.56)	6	12.11	0.50 (0.18 - 1.08)
COPD	1	1.31	0.77 (0.02 - 4.26)	0	1.66	-	2	7.16	0.28 (0.03 - 1.01)
All Digestive	**1**	**6.64**	**0.15 (0.00 - 0.84)**	1	4.66	0.21 (0.01 - 1.20)	6	7.54	0.80 (0.29 - 1.73)
Diseases of the Liver	0	5.10	-	1	3.52	0.28 (0.01 - 1.58)	4	4.74	0.84 (0.23 - 2.16)
All Injury & Trauma	47	60.15	0.78 (0.57 - 1.04)	14	16.80	0.83 (0.46 - 1.40)	**4**	**11.55**	**0.35 (0.09 - 0.89)**
All Accidents	28	30.95	0.90 (0.60 - 1.31)	8	8.41	0.95 (0.41 - 1.87)	4	6.29	0.64 (0.17 - 1.63)
Fire	1	0.51	1.96 (0.05 - 10.90)	1	0.20	4.91 (0.12 - 27.36)	0	0.18	-
Suicide	16	24.37	0.66 (0.38 - 1.07)	5	7.01	0.71 (0.23 - 1.67)	0	4.30	-
All Other Causes	**5**	**18.15**	**0.28 (0.09 - 0.64)**	4	9.55	0.42 (0.11 - 1.07)	**5**	**17.64**	**0.28 (0.09 - 0.66)**
Dementia & Alzheimers	0	0.21	-	1	0.30	3.35 (0.08 - 18.65)	1	1.98	0.50 (0.01 - 2.81)
Diabetes	0	2.38	-	1	1.99	0.50 (0.01 - 2.80)	0	5.28	-

* Statistically significantly reduced SMR results are in **blue**

Table 28: Standardised Mortality Ratios* and 95% confidence intervals for male volunteer firefighter deaths to 30/11/2011 by duration of service compared to the Australian population

Cause of Death Categories	> 3 months to 10 years			10 to 20 years			20+ years		
	O	E	SMR (95%CI)	O	E	SMR (95%CI)	O	E	SMR (95%CI)
All Causes of Death Combined	**1444**	**2494.55**	**0.58 (0.55 - 0.61)**	**839**	**1560.58**	**0.54 (0.50 - 0.58)**	**2267**	**4491.78**	**0.50 (0.48 - 0.53)**
All Malignancies	**582**	**873.17**	**0.67 (0.61 - 0.72)**	**342**	**569.89**	**0.60 (0.54 - 0.67)**	**949**	**1714.88**	**0.55 (0.52 - 0.59)**
All Nervous System	**29**	**75.43**	**0.38 (0.26 - 0.55)**	**30**	**46.86**	**0.64 (0.43 - 0.91)**	**60**	**139.94**	**0.43 (0.33 - 0.55)**
All Circulatory	**291**	**611.31**	**0.48 (0.42 - 0.53)**	**223**	**415.84**	**0.54 (0.47 - 0.61)**	**706**	**1364.93**	**0.52 (0.48 - 0.56)**
Hypertensive	6	11.96	0.50 (0.18 - 1.09)	5	8.41	0.59 (0.19 - 1.39)	19	29.62	0.64 (0.39 - 1.00)
Ischaemic Heart Disease	**162**	**373.81**	**0.43 (0.37 - 0.51)**	**132**	**253.78**	**0.52 (0.44 - 0.62)**	**410**	**812.73**	**0.50 (0.46 - 0.56)**
Cerebrovascular	**49**	**97.08**	**0.50 (0.37 - 0.67)**	**33**	**68.88**	**0.48 (0.33 - 0.67)**	**99**	**251.17**	**0.39 (0.32 - 0.48)**
All Respiratory	**54**	**135.62**	**0.40 (0.30 - 0.52)**	**29**	**94.96**	**0.31 (0.20 - 0.44)**	**128**	**346.2**	**0.37 (0.31 - 0.44)**
COPD	**28**	**69.99**	**0.40 (0.27 - 0.58)**	**18**	**50.27**	**0.36 (0.21 - 0.57)**	**65**	**191.16**	**0.34 (0.26 - 0.43)**
All Digestive	**37**	**101.11**	**0.37 (0.26 - 0.50)**	**20**	**64.49**	**0.31 (0.19 - 0.48)**	**50**	**168.64**	**0.30 (0.22 - 0.39)**
Diseases of the Liver	**19**	**66.26**	**0.29 (0.17 - 0.45)**	**12**	**40.76**	**0.29 (0.15 - 0.51)**	**18**	**89.12**	**0.20 (0.12 - 0.32)**
All Injury & Trauma	**352**	**442.30**	**0.80 (0.71 - 0.88)**	**126**	**203.63**	**0.62 (0.52 - 0.74)**	**170**	**269.37**	**0.63 (0.54 - 0.73)**
All Accidents	210	239.31	0.88 (0.76 - 1.00)	**79**	**107.88**	**0.73 (0.58 - 0.91)**	**107**	**153.85**	**0.70 (0.57 - 0.84)**
Fire	8	4.21	1.90 (0.82 - 3.74)	5	2.22	2.25 (0.73 - 5.25)	6	3.81	1.58 (0.58 - 3.43)
Suicide	**117**	**195.23**	**0.60 (0.50 - 0.72)**	**38**	**78.62**	**0.48 (0.34 - 0.66)**	**48**	**92.09**	**0.52 (0.38 - 0.69)**
All Other Causes	116	134.42	0.86 (0.71 - 1.04)	**66**	**164.91**	**0.40 (0.31 - 0.51)**	**200**	**487.82**	**0.41 (0.36 - 0.47)**
Dementia & Alzheimers	62	76.25	0.81 (0.62 - 1.04)	**12**	**21.30**	**0.56 (0.29 - 0.98)**	**37**	**96.42**	**0.38 (0.27 - 0.53)**
Diabetes	58	70.30	0.83 (0.63 - 1.07)	**15**	**40.15**	**0.37 (0.21 - 0.62)**	**48**	**129.21**	**0.37 (0.27 - 0.49)**

* Statistically significantly reduced SMR results are in **blue**

Table 29: Standardised Mortality Ratios* and 95% confidence intervals for female volunteer firefighters deaths to 30/11/2011 by duration of service compared to the Australian population

Cause of Death Categories	> 3 months to 10 years			10 to 20 years			20+ years		
	O	E	SMR (95%CI)	O	E	SMR (95%CI)	O	E	SMR (95%CI)
All Causes of Death Combined	**270**	**427.06**	**0.63 (0.56 - 0.71)**	**119**	**190.31**	**0.63 (0.52 - 0.75)**	**118**	**183.72**	**0.64 (0.53 - 0.77)**
All Malignancies	**140**	**192.17**	**0.73 (0.61 - 0.86)**	**60**	**85.90**	**0.70 (0.53 - 0.90)**	**61**	**72.54**	**0.84 (0.64 - 1.08)**
All Nervous System	**4**	**16.19**	**0.25 (0.07 - 0.63)**	6	7.26	0.83 (0.30 - 1.80)	**1**	**7.44**	**0.13 (0.00 - 0.75)**
All Circulatory	**38**	**84.99**	**0.45 (0.32 - 0.61)**	**28**	**42.28**	**0.66 (0.44 - 0.96)**	**28**	**51.07**	**0.55 (0.36 - 0.79)**
Hypertensive	0	2.70	-	1	1.43	0.07 (0.02 - 3.91)	0	1.92	-
Ischaemic Heart Disease	**18**	**36.65**	**0.49 (0.29 - 0.78)**	**10**	**18.71**	**0.53 (0.26 - 0.98)**	**8**	**22.92**	**0.35 (0.15 - 0.69)**
Cerebrovascular	**9**	**22.71**	**0.40 (0.18 - 0.75)**	6	11.35	0.53 (0.19 - 1.15)	8	14	0.57 (0.25 - 1.13)
All Respiratory	**13**	**26.76**	**0.49 (0.26 - 0.83)**	**4**	**13.18**	**0.30 (0.08 - 0.78)**	**3**	**14.49**	**0.21 (0.04 - 0.61)**
COPD	**5**	**13.40**	**0.37 (0.12 - 0.87)**	3	6.95	0.43 (0.09 - 1.26)	**2**	**7.54**	**0.27 (0.03 - 0.96)**
All Digestive	**6**	**15.66**	**0.38 (0.14 - 0.83)**	6	6.97	0.86 (0.32 - 1.87)	2	6.5	0.31 (0.04 - 1.11)
Diseases of the Liver	**1**	**8.08**	**0.12 (0.00 - 0.69)**	2	3.23	0.62 (0.08 - 2.24)	1	2.15	0.46 (0.01 - 2.59)
All Injury & Trauma	46	41.44	1.11 (0.81 - 1.48)	10	11.97	0.84 (0.40 - 1.54)	8	7.11	1.13 (0.49 - 2.22)
All Accidents	32	22.76	1.41 (0.96 - 1.99)	7	6.85	1.02 (0.41 - 2.11)	7	4.71	1.49 (0.60 - 3.06)
Fire	2	1.25	1.60 (0.19 - 5.76)	0	0.41	-	0	0.23	-
Suicide	12	13.49	0.89 (0.46 - 1.55)	2	3.63	0.55 (0.07 - 1.99)	0	1.58	-
All Other Causes	**23**	**49.85**	**0.46 (0.29 - 0.69)**	**5**	**22.76**	**0.22 (0.07 - 0.51)**	**14**	**24.56**	**0.57 (0.31 - 0.96)**
Dementia & Alzheimers	4	7.66	0.52 (0.14 - 1.34)	4	4.52	0.89 (0.24 - 2.27)	5	6.79	0.74 (0.24 - 1.72)
Diabetes	4	10.14	0.39 (0.11 - 1.01)	2	4.96	0.40 (0.05 - 1.46)	4	5.26	0.76 (0.21 - 1.95)

* Statistically significantly reduced SMR results are in **blue**

Table 30: Standardised Cancer Incidence Ratios* and 95% confidence intervals for male career full-time firefighters to 31/12/2010 by duration of employment compared to the Australian population

Cancer Categories	> 3 months to 10 years			10 to 20 years			20+ years		
	O	E	SMR (95%CI)	O	E	SMR (95%CI)	O	E	SMR (95%CI)
All Malignancies	138	131.18	1.05 (0.88 - 1.24)	196	184.88	1.06 (0.92 - 1.22)	**866**	**795.93**	**1.09 (1.02 - 1.16)**
Lip, Oral Cavity & Pharynx	9	8.62	1.04 (0.48 - 1.98)	12	12.68	0.95 (0.49 - 1.65)	34	36.28	0.94 (0.65 - 1.31)
Lip	6	4.08	1.47 (0.54 - 3.20)	5	5.29	0.95 (0.31 - 2.21)	12	11.17	1.07 (0.56 - 1.88)
Digestive Organs	20	20.64	0.97 (0.59 - 1.50)	27	34.84	0.77 (0.51 - 1.13)	183	172.91	1.06 (0.91 - 1.22)
Oesophagus	0	1.35	-	3	2.34	1.28 (0.26 - 3.75)	9	11.98	0.75 (0.34 - 1.43)
Stomach	1	2.24	0.45 (0.01 - 2.49)	1	3.90	0.26 (0.01 - 1.43)	22	18.23	1.21 (0.76 - 1.83)
Colorectal	14	12.72	1.10 (0.60 - 1.85)	20	21.46	0.93 (0.57 - 1.44)	123	109.43	1.12 (0.93 - 1.34)
Colon	7	6.84	1.02 (0.41 - 2.11)	12	11.67	1.03 (0.53 - 1.80)	73	62.41	1.17 (0.92 - 1.47)
Rectum	6	4.37	1.37 (0.50 - 2.99)	7	7.25	0.97 (0.39 - 1.99)	42	34.45	1.22 (0.88 - 1.65)
Liver	1	1.66	0.60 (0.02 - 3.35)	0	2.63	-	7	10.90	0.64 (0.26 - 1.32)
Pancreas	3	1.72	1.75 (0.36 - 5.11)	2	2.98	0.67 (0.08 - 2.43)	17	15.71	1.08 (0.63 - 1.73)
Respiratory	9	8.59	1.05 (0.48 - 1.99)	15	15.82	0.95 (0.53 - 1.56)	**75**	**97.80**	**0.77 (0.60 - 0.96)**
Larynx	1	0.95	1.05 (0.03 - 5.85)	3	1.82	1.65 (0.34 - 4.81)	7	9.88	0.71 (0.28 - 1.46)
Lung	8	7.00	1.14 (0.49 - 2.25)	11	13.2	0.83 (0.42 - 1.49)	**66**	**85.74**	**0.77 (0.60 - 0.98)**
Melanoma	35	26.28	1.33 (0.93 - 1.85)	**50**	**33.27**	**1.50 (1.12 - 1.98)**	**122**	**83.36**	**1.46 (1.22 - 1.75)**
Mesothelioma	**3**	**0.52**	**5.82 (1.20 - 17.00)**	2	1.00	2.01 (0.24 - 7.25)	6	6.74	0.89 (0.33 - 1.94)
Male Reproductive	40	29.31	1.36 (0.98 - 1.86)	37	37.82	0.98 (0.69 - 1.35)	**277**	**228.58**	**1.21 (1.07 - 1.36)**
Prostate	23	18.24	1.26 (0.80 - 1.89)	30	29.74	1.01 (0.68 - 1.44)	**269**	**213.9**	**1.26 (1.11 - 1.42)**
Testis	17	10.33	1.65 (0.96 - 2.63)	7	7.05	0.99 (0.40 - 2.05)	7	3.78	1.85 (0.74 - 3.81)
Urinary tract	2	6.33	0.32 (0.04 - 1.14)	12	10.55	1.14 (0.59 - 1.99)	45	47.55	0.95 (0.69 - 1.27)
Kidney	1	4.14	0.24 (0.01 - 1.35)	7	6.54	1.07 (0.43 - 2.21)	25	23.11	1.08 (0.70 - 1.60)
Bladder	1	1.93	0.52 (0.01 - 2.88)	4	3.52	1.14 (0.31 - 2.91)	18	21.54	0.84 (0.50 - 1.32)
Brain & Other CNS	3	4.22	0.71 (0.15 - 2.08)	4	4.94	0.81 (0.22 - 2.07)	10	12.51	0.80 (0.38 - 1.47)
Brain	3	4.00	0.75 (0.15 - 2.19)	4	4.69	0.85 (0.23 - 2.18)	9	12.06	0.75 (0.34 - 1.42)

Cancer Categories	> 3 months to 10 years			10 to 20 years			20+ years		
	O	E	SMR (95%CI)	O	E	SMR (95%CI)	O	E	SMR (95%CI)
Thyroid & Other Endocrine	3	2.94	1.02 (0.21 - 2.98)	6	3.21	1.87 (0.69 - 4.06)	4	5.74	0.70 (0.19 - 1.78)
Thyroid	3	2.70	1.11 (0.23 - 3.25)	6	2.95	2.03 (0.75 - 4.43)	4	5.27	0.76 (0.21 - 1.94)
Unknown Site	2	2.38	0.84 (0.10 - 3.04)	4	4.15	0.96 (0.26 - 2.47)	21	20.59	1.02 (0.63 - 1.56)
Lympho-haematopoetic	10	17.14	0.58 (0.28 - 1.07)	22	21.94	1.00 (0.63 - 1.52)	75	74.17	1.01 (0.80 - 1.27)
Hodgkin Disease	1	2.39	0.42 (0.01 - 2.33)	2	1.80	1.11 (0.13 - 4.02)	3	2.29	1.31 (0.27 - 3.82)
Non-Hodgkin Lymphoma	5	7.42	0.67 (0.22 - 1.57)	9	10.07	0.89 (0.41 - 1.70)	31	30.11	1.03 (0.70 - 1.46)
Follicular-NHL	2	1.89	1.06 (0.13 - 3.83)	3	2.75	1.09 (0.22 - 3.19)	11	7.25	1.52 (0.76 - 2.72)
Diffuse-NHL	3	3.48	0.86 (0.18 - 2.52)	3	4.61	0.65 (0.13 - 1.90)	15	14.36	1.04 (0.58 - 1.72)
Myeloma	1	1.16	0.86 (0.02 - 4.79)	1	2.05	0.49 (0.01 - 2.72)	13	9.80	1.33 (0.71 - 2.27)
Leukaemia	3	4.42	0.68 (0.14 - 1.98)	8	5.60	1.43 (0.62 - 2.82)	17	20.24	0.84 (0.49 - 1.34)
MDS	0	0.32	-	0	0.45	-	4	3.60	1.11 (0.30 - 2.84)
All Other Cancers	2	4.21	0.47 (0.06 - 1.71)	5	4.66	1.07 (0.35 - 2.51)	14	9.70	1.44 (0.79 - 2.42)
Male Breast	0	0.20	-	0	0.34	-	**5**	**1.45**	**3.44 (1.12 - 8.04)**

* Statistically significantly elevated SIR results are in **red**, statistically significantly reduced SIR results are in **blue**

Table 31: Standardised Cancer Incidence Ratios* and 95% confidence intervals for male part-time paid firefighters to 31/12/2010 by duration of employment compared to the Australian population

Cancer Categories	> 3 months to 10 years			10 to 20 years			20+ years		
	O	E	SIR (95%CI)	O	E	SIR (95%CI)	O	E	SIR (95%CI)
All Malignancies	144	134.86	1.07 (0.90 - 1.26)	114	99.40	1.15 (0.95 - 1.38)	223	202.45	1.10 (0.96 - 1.26)
Lip, Oral Cavity & Pharynx	11	9.21	1.19 (0.60 - 2.14)	6	5.93	1.01 (0.37 - 2.20)	4	8.29	0.48 (0.13 - 1.24)
Lip	8	4.06	1.97 (0.85 - 3.88)	2	2.06	0.97 (0.12 - 3.50)	1	2.46	0.41 (0.01 - 2.26)
Digestive Organs	25	22.29	1.12 (0.73 - 1.66)	17	19.78	0.86 (0.50 - 1.38)	43	43.26	0.99 (0.72 - 1.34)
Oesophagus	1	1.49	0.67 (0.02 - 3.73)	1	1.40	0.72 (0.02 - 3.99)	3	2.98	1.01 (0.21 - 2.94)
Stomach	3	2.35	1.28 (0.26 - 3.73)	3	2.01	1.49 (0.31 - 4.36)	3	4.33	0.69 (0.14 - 2.02)
Colorectal	16	13.62	1.17 (0.67 - 1.91)	11	12.27	0.90 (0.45 - 1.60)	30	27.64	1.09 (0.73 - 1.55)
Colon	8	7.17	1.12 (0.48 - 2.20)	4	6.56	0.61 (0.17 - 1.56)	15	15.77	0.95 (0.53 - 1.57)
Rectum	5	4.82	1.04 (0.34 - 2.42)	6	4.22	1.42 (0.52 - 3.09)	10	8.70	1.15 (0.55 - 2.11)
Liver	1	1.92	0.52 (0.01 - 2.91)	1	1.53	0.65 (0.02 - 3.64)	2	2.75	0.73 (0.09 - 2.63)
Pancreas	3	1.86	1.61 (0.33 - 4.71)	0	1.75	-	4	3.92	1.02 (0.28 - 2.61)
Respiratory	5	8.79	0.57 (0.18 - 1.33)	2	**9.08**	**0.22 (0.03 - 0.80)**	**10**	**23.68**	**0.42 (0.20 - 0.78)**
Larynx	0	1.00	-	0	1.06	-	1	2.34	0.43 (0.01 - 2.38)
Lung	4	7.13	0.56 (0.15 - 1.44)	2	**7.66**	**0.26 (0.03 - 0.94)**	**9**	**20.84**	**0.43 (0.20 - 0.82)**
Melanoma	36	26.85	1.34 (0.94 - 1.86)	15	14.86	1.01 (0.56 - 1.66)	**36**	**20.23**	**1.78 (1.25 - 2.46)**
Mesothelioma	1	0.50	2.00 (0.05 - 11.12)	1	0.62	1.62 (0.04 - 9.04)	2	1.78	1.12 (0.14 - 4.05)
Male Reproductive	32	28.80	1.11 (0.76 - 1.57)	**47**	**25.42**	**1.85 (1.36 - 2.46)**	**86**	**64.11**	**1.34 (1.07 - 1.66)**
Prostate	26	18.34	1.42 (0.93 - 2.08)	**41**	**22.32**	**1.84 (1.32 - 2.49)**	**85**	**60.09**	**1.41 (1.13 - 1.75)**
Testis	6	9.84	0.61 (0.22 - 1.33)	5	2.16	2.32 (0.75 - 5.41)	0	0.70	-
Urinary tract	4	6.86	0.58 (0.16 - 1.49)	9	5.62	1.60 (0.73 - 3.04)	12	11.48	1.05 (0.54 - 1.83)
Kidney	3	4.78	0.63 (0.13 - 1.83)	8	3.51	2.28 (0.98 - 4.49)	8	5.76	1.39 (0.60 - 2.73)
Bladder	1	1.81	0.55 (0.01 - 3.07)	1	1.85	0.54 (0.01 - 3.02)	3	5.02	0.60 (0.12 - 1.75)
Brain & Other CNS	4	4.24	0.94 (0.26 - 2.41)	3	2.19	1.37 (0.28 - 4.00)	6	2.97	2.02 (0.74 - 4.40)
Brain	3	4.02	0.75 (0.15 - 2.18)	3	2.10	1.43 (0.29 - 4.18)	6	2.87	2.09 (0.77 - 4.55)

Cancer Categories	> 3 months to 10 years			10 to 20 years			20+ years		
	O	E	SIR (95%CI)	O	E	SIR (95%CI)	O	E	SIR (95%CI)
Thyroid & Other Endocrine	2	3.25	0.62 (0.07 - 2.22)	2	1.39	1.44 (0.17 - 5.20)	3	1.34	2.24 (0.46 - 6.54)
Thyroid	2	3.00	0.67 (0.08 - 2.41)	2	1.29	1.56 (0.19 - 5.62)	3	1.23	2.44 (0.50 - 7.14)
Unknown Site	2	2.45	0.82 (0.10 - 2.95)	3	2.10	1.43 (0.29 - 4.17)	1	4.73	0.21 (0.01 - 1.18)
Lympho-haematopoetic	18	17.93	1.00 (0.60 - 1.59)	7	10.63	0.66 (0.26 - 1.36)	18	18.32	0.98 (0.58 - 1.55)
Hodgkin Disease	3	2.35	1.28 (0.26 - 3.73)	1	0.63	1.59 (0.04 - 8.84)	0	0.49	-
Non-Hodgkin Lymphoma	6	7.72	0.78 (0.29 - 1.69)	3	4.72	0.64 (0.13 - 1.86)	10	7.36	1.36 (0.65 - 2.50)
Follicular-NHL	2	2.06	0.97 (0.12 - 3.51)	1	1.32	0.75 (0.02 - 4.21)	4	1.77	2.25 (0.61 - 5.77)
Diffuse-NHL	3	3.62	0.83 (0.17 - 2.42)	2	2.16	0.93 (0.11 - 3.35)	4	3.55	1.13 (0.31 - 2.88)
Myeloma	1	1.29	0.78 (0.02 - 4.33)	0	1.17	-	2	2.46	0.81 (0.10 - 2.94)
Leukaemia	7	4.61	1.52 (0.61 - 3.13)	3	2.75	1.09 (0.22 - 3.18)	5	4.96	1.01 (0.33 - 2.35)
MDS	0	0.33	-	0	0.29	-	0	0.98	-
All Other Cancers	4	3.69	1.08 (0.30 - 2.78)	2	1.77	1.13 (0.14 - 4.07)	2	2.27	0.88 (0.11 - 3.19)
Male Breast	1	0.21	4.68 (0.12 - 26.06)	0	0.18	-	0	0.36	-

* Statistically significantly elevated SIR results are in **red**, statistically significantly reduced SIR results are in **blue**

Table 32: Standardised Cancer Incidence Ratios* and 95% confidence intervals for male volunteer firefighters to 31/12/2010 by duration of service compared to the Australian population

Cancer Categories	> 3 months to 10 years			10 to 20 years			20+ years		
	O	E	SIR (95%CI)	O	E	SIR (95%CI)	O	E	SIR (95%CI)
All Malignancies	**2206**	**2483.68**	**0.89 (0.85 - 0.93)**	**1315**	**1533.31**	**0.86 (0.81 - 0.91)**	**3452**	**4103.85**	**0.84 (0.81 - 0.87)**
Lip, Oral Cavity & Pharynx	**82**	**114.16**	**0.72 (0.57 - 0.89)**	**48**	**70.07**	**0.69 (0.51 - 0.91)**	**111**	**155.03**	**0.72 (0.59 - 0.86)**
Lip	33	37.99	0.87 (0.60 - 1.22)	23	23.07	1.00 (0.63 - 1.50)	**69**	**46.51**	**1.48 (1.15 - 1.88)**
Digestive Organs	**397**	**482.73**	**0.82 (0.74 - 0.91)**	**220**	**308.15**	**0.71 (0.62 - 0.81)**	**662**	**869.01**	**0.76 (0.70 - 0.82)**
Oesophagus	**21**	**33.95**	**0.62 (0.38 - 0.95)**	18	21.67	0.83 (0.49 - 1.31)	**38**	**60.66**	**0.63 (0.44 - 0.86)**
Stomach	**32**	**47.10**	**0.68 (0.46 - 0.96)**	21	30.48	0.69 (0.43 - 1.05)	**62**	**87.46**	**0.71 (0.54 - 0.91)**
Colorectal	268	301.39	0.89 (0.79 - 1.00)	**147**	**192.26**	**0.76 (0.65 - 0.90)**	**469**	**546.9**	**0.86 (0.78 - 0.94)**
Colon	149	168.83	0.88 (0.75 - 1.04)	**85**	**108.54**	**0.78 (0.63 - 0.97)**	284	319.42	0.89 (0.79 - 1.00)
Rectum	98	99.21	0.99 (0.80 - 1.20)	**45**	**62.57**	**0.72 (0.52 - 0.96)**	154	168.98	0.91 (0.77 - 1.07)
Liver	**18**	**36.24**	**0.50 (0.29 - 0.78)**	**8**	**22.72**	**0.35 (0.15 - 0.69)**	**12**	**58.28**	**0.21 (0.11 - 0.36)**
Pancreas	36	44.30	0.81 (0.57 - 1.13)	**13**	**28.48**	**0.46 (0.24 - 0.78)**	65	82.02	0.79 (0.61 - 1.01)
Respiratory	**136**	**237.11**	**0.57 (0.48 - 0.68)**	**101**	**153.82**	**0.66 (0.53 - 0.80)**	**187**	**468.59**	**0.40 (0.34 - 0.46)**
Larynx	**13**	**23.29**	**0.56 (0.30 - 0.95)**	12	14.91	0.80 (0.42 - 1.41)	**10**	**41.67**	**0.24 (0.12 - 0.44)**
Lung	**114**	**206.00**	**0.55 (0.46 - 0.66)**	**86**	**134.39**	**0.64 (0.51 - 0.79)**	**168**	**416.81**	**0.40 (0.34 - 0.47)**
Melanoma	336	310.47	1.08 (0.97 - 1.20)	194	186.26	1.04 (0.90 - 1.20)	370	409.36	0.90 (0.81 - 1.00)
Mesothelioma	20	17.09	1.17 (0.71 - 1.81)	6	11.26	0.53 (0.20 - 1.16)	**16**	**36.02**	**0.44 (0.25 - 0.72)**
Male Reproductive	752	762.83	0.99 (0.92 - 1.06)	497	465.01	1.07 (0.98 - 1.17)	**1480**	**1305.66**	**1.13 (1.08 - 1.19)**
Prostate	701	682.98	1.03 (0.95 - 1.11)	**470**	**423.83**	**1.11 (1.01 - 1.21)**	**1451**	**1232.74**	**1.18 (1.12 - 1.24)**
Testis	48	60.38	0.80 (0.59 - 1.05)	25	26.55	0.94 (0.61 - 1.39)	25	19.01	1.31 (0.85 - 1.94)
Urinary tract	**105**	**133.32**	**0.79 (0.64 - 0.95)**	**56**	**85.25**	**0.66 (0.50 - 0.85)**	**169**	**237.51**	**0.71 (0.61 - 0.83)**
Kidney	65	75.86	0.86 (0.66 - 1.09)	**32**	**46.97**	**0.68 (0.47 - 0.96)**	98	114.50	0.86 (0.69 - 1.04)
Bladder	**34**	**50.55**	**0.67 (0.47 - 0.94)**	**18**	**33.69**	**0.53 (0.32 - 0.84)**	**62**	**108.55**	**0.57 (0.44 - 0.73)**
Brain & Other CNS	52	47.47	1.10 (0.82 - 1.44)	21	27.57	0.76 (0.47 - 1.16)	**41**	**57.93**	**0.71 (0.51 - 0.96)**
Brain	51	45.49	1.12 (0.83 - 1.47)	21	26.47	0.79 (0.49 - 1.21)	**40**	**55.93**	**0.72 (0.51 - 0.97)**

Cancer Categories	> 3 months to 10 years			10 to 20 years			20+ years		
	O	E	SIR (95%CI)	O	E	SIR (95%CI)	O	E	SIR (95%CI)
Thyroid & Other Endocrine	28	30.25	0.93 (0.62 - 1.34)	9	16.64	0.54 (0.25 - 1.03)	22	28.54	0.77 (0.48 - 1.17)
Thyroid	25	27.85	0.90 (0.58 - 1.33)	9	15.43	0.58 (0.27 - 1.11)	22	26.27	0.84 (0.52 - 1.27)
Unknown Site	**32**	**49.99**	**0.64 (0.44 - 0.90)**	**19**	**32.94**	**0.58 (0.35 - 0.90)**	**50**	**99.09**	**0.50 (0.37 - 0.67)**
Lympho-haematopoetic	239	260.62	0.92 (0.80 - 1.04)	**126**	**155.10**	**0.81 (0.68 - 0.97)**	**296**	**391.67**	**0.76 (0.67 - 0.85)**
Hodgkin Disease	15	19.52	0.77 (0.43 - 1.27)	9	7.99	1.13 (0.51 - 2.14)	9	10.70	0.84 (0.38 - 1.60)
Non-Hodgkin Lymphoma	100	104.35	0.96 (0.78 - 1.17)	48	62.97	0.76 (0.56 - 1.01)	**118**	**150.63**	**0.78 (0.65 - 0.94)**
Follicular-NHL	27	26.74	1.01 (0.67 - 1.47)	15	16.18	0.93 (0.52 - 1.53)	32	35.34	0.91 (0.62 - 1.28)
Diffuse-NHL	49	49.47	0.99 (0.73 - 1.31)	**18**	**29.63**	**0.61 (0.36 - 0.96)**	58	72.25	0.80 (0.61 - 1.04)
Myeloma	24	28.27	0.85 (0.54 - 1.26)	11	18.23	0.60 (0.30 - 1.08)	38	51.47	0.74 (0.52 - 1.01)
Leukaemia	72	68.66	1.05 (0.82 - 1.32)	38	40.76	0.93 (0.66 - 1.28)	**84**	**104.56**	**0.80 (0.64 - 0.99)**
MDS	15	13.28	1.13 (0.63 - 1.86)	5	8.57	0.58 (0.19 - 1.36)	22	29.03	0.76 (0.47 - 1.15)
All Other Cancers	27	37.63	0.72 (0.47 - 1.04)	18	21.21	0.85 (0.50 - 1.34)	48	45.45	1.06 (0.78 - 1.40)
Male Breast	1	4.24	0.24 (0.01 - 1.31)	0	2.69	-	11	7.36	1.49 (0.75 - 2.67)

* Statistically significantly elevated SIR results are in **red**, statistically significantly reduced SIR results are in **blue**

Table 33: Standardised Cancer Incidence Ratios* and 95% confidence intervals for female volunteer firefighters to 31/12/2010 by duration of service compared to the Australian population

Cancer Categories	> 3 months to 10 years			10 to 20 years			20+ years		
	O	E	SMR (95%CI)	O	E	SMR (95%CI)	O	E	SMR (95%CI)
All Malignancies	614	620.05	0.99 (0.91 - 1.07)	220	247.6	0.89 (0.77 - 1.01)	162	171.90	0.94 (0.80 - 1.10)
Lip, Oral Cavity & Pharynx	8	11.49	0.70 (0.30 - 1.37)	4	4.61	0.87 (0.24 - 2.22)	4	3.20	1.25 (0.34 - 3.20)
Lip	3	2.93	1.02 (0.21 - 2.99)	0	1.20	-	3	0.86	3.50 (0.72 - 10.21)
Digestive Organs	97	88.85	1.09 (0.89 - 1.33)	31	39.57	0.78 (0.53 - 1.11)	27	32.76	0.82 (0.54 - 1.20)
Oesophagus	2	2.75	0.73 (0.09 - 2.62)	1	1.31	0.76 (0.02 - 4.25)	0	1.20	-
Stomach	4	6.42	0.62 (0.17 - 1.60)	0	2.77	-	0	2.23	-
Colorectal	78	62.91	1.24 (0.98 - 1.55)	27	27.88	0.97 (0.64 - 1.41)	20	22.76	0.88 (0.54 - 1.36)
Colon	47	39.51	1.19 (0.87 - 1.58)	18	17.80	1.01 (0.60 - 1.60)	11	15.17	0.72 (0.36 - 1.30)
Rectum	23	15.74	1.46 (0.93 - 2.19)	7	6.75	1.04 (0.42 - 2.14)	7	5.10	1.37 (0.55 - 2.83)
Liver	0	3.15	-	0	1.36	-	1	1.12	0.90 (0.02 - 4.99)
Pancreas	7	8.78	0.80 (0.32 - 1.64)	1	4.07	0.25 (0.01 - 1.37)	4	3.63	1.10 (0.30 - 2.82)
Respiratory	42	39.16	1.07 (0.77 - 1.45)	12	17.78	0.67 (0.35 - 1.18)	10	14.75	0.68 (0.33 - 1.25)
Larynx	0	0.74	-	0	0.34	-	0	0.27	-
Lung	42	37.19	1.13 (0.81 - 1.53)	11	16.99	0.65 (0.32 - 1.16)	10	14.18	0.71 (0.34 - 1.30)
Melanoma	**98**	**74.08**	**1.32 (1.07 - 1.61)**	28	26.15	1.07 (0.71 - 1.55)	16	15.54	1.03 (0.59 - 1.67)
Mesothelioma	1	1.10	0.91 (0.02 - 5.08)	1	0.49	2.03 (0.05 - 11.33)	1	0.41	2.45 (0.06 - 13.64)
Breast	212	216.69	0.98 (0.85 - 1.12)	70	86.26	0.81 (0.63 - 1.03)	59	54.46	1.08 (0.82 - 1.40)
Female-Reproductive	**44**	**65.30**	**0.67 (0.49 - 0.90)**	29	25.63	1.13 (0.76 - 1.63)	13	17.14	0.76 (0.40 - 1.30)
Cervix	5	15.12	0.33 (0.11 - 0.77)	5	4.76	1.05 (0.34 - 2.45)	2	2.22	0.90 (0.11 - 3.26)
Urinary tract	15	16.10	0.93 (0.52 - 1.54)	2	7.04	0.28 (0.03 - 1.03)	5	5.67	0.88 (0.29 - 2.06)
Kidney	12	11.02	1.09 (0.56 - 1.90)	2	4.60	0.44 (0.05 - 1.57)	4	3.33	1.20 (0.33 - 3.07)
Bladder	1	3.86	0.26 (0.01 - 1.44)	0	1.84	-	1	1.72	0.58 (0.01 - 3.23)
Brain & Other CNS	6	9.14	0.66 (0.24 - 1.43)	4	3.34	1.20 (0.33 - 3.07)	4	2.21	1.81 (0.49 - 4.64)
Brain	4	8.60	0.47 (0.13 - 1.19)	4	3.15	1.27 (0.35 - 3.25)	4	2.09	1.91 (0.52 - 4.90)

Cancer Categories	> 3 months to 10 years			10 to 20 years			20+ years		
	O	E	SMR (95%CI)	O	E	SMR (95%CI)	O	E	SMR (95%CI)
Thyroid & Other Endocrine	26	27.48	0.95 (0.62 - 1.39)	9	8.60	1.05 (0.48 - 1.99)	4	4.13	0.97 (0.26 - 2.48)
Thyroid	24	26.88	0.89 (0.57 - 1.33)	9	8.40	1.07 (0.49 - 2.03)	4	4.01	1.00 (0.27 - 2.56)
Unknown	8	10.26	0.78 (0.34 - 1.54)	5	4.66	1.07 (0.35 - 2.50)	2	4.14	0.48 (0.06 - 1.74)
Lympho-haematopoetic	54	52.57	1.03 (0.77 - 1.34)	21	20.64	1.02 (0.63 - 1.56)	13	15.59	0.83 (0.44 - 1.43)
Hodgkin Disease	5	4.51	1.11 (0.36 - 2.59)	2	0.94	2.13 (0.26 - 7.70)	1	0.41	2.42 (0.06 - 13.49)
Non-Hodgkin Lymphoma	25	21.60	1.16 (0.75 - 1.71)	9	8.84	1.02 (0.47 - 1.93)	4	6.57	0.61 (0.17 - 1.56)
Follicular-NHL	11	6.58	1.67 (0.83 - 2.99)	2	2.67	0.75 (0.09 - 2.71)	1	1.81	0.55 (0.01 - 3.07)
Diffuse-NHL	10	8.85	1.13 (0.54 - 2.08)	4	3.65	1.09 (0.30 - 2.80)	1	2.83	0.35 (0.01 - 1.97)
Myeloma	3	5.47	0.55 (0.11 - 1.60)	4	2.48	1.61 (0.44 - 4.12)	5	2.07	2.41 (0.78 - 5.62)
Leukaemia	16	12.17	1.31 (0.75 - 2.14)	5	4.75	1.05 (0.34 - 2.46)	2	3.56	0.56 (0.07 - 2.03)
MDS	1	2.35	0.43 (0.01 - 2.37)	1	1.06	0.95 (0.02 - 5.28)	1	1.02	0.98 (0.02 - 5.45)
All Other Cancers	3	7.85	0.38 (0.08 - 1.12)	4	2.82	1.42 (0.39 - 3.63)	4	1.91	2.09 (0.57 - 5.36)

* Statistically significantly elevated SIR results are in **red**, statistically significantly reduced SIR results are in **blue**

Table 34: Standardised Mortality Ratios* and 95% confidence intervals for male career full-time firefighter deaths to 30/11/2011 by era of first employment compared to the Australian population

Cause of Death Categories	Pre-1970 (N=1906)			1970 - 1994 (N=8114)			1995+ (N=7371)		
	O	E	SMR (95%CI)	O	E	SMR (95%CI)	O	E	SMR (95%CI)
All Causes of Death Combined	**459**	**593.39**	**0.77 (0.70 - 0.85)**	**279**	**477.89**	**0.58 (0.52 - 0.66)**	**42**	**98.67**	**0.43 (0.31 - 0.58)**
All Malignancies	200	229.50	0.87 (0.75 - 1.00)	**113**	**155.51**	**0.73 (0.60 - 0.87)**	16	22.76	0.70 (0.40 - 1.14)
All Nervous System	15	14.94	1.00 (0.56 - 1.66)	**5**	**12.32**	**0.41 (0.13 - 0.95)**	0	2.93	-
All Circulatory	**137**	**200.03**	**0.68 (0.58 - 0.81)**	**65**	**110.33**	**0.59 (0.45 - 0.75)**	**7**	**17.38**	**0.40 (0.16 - 0.83)**
Hypertensive	4	3.74	1.07 (0.29 - 2.74)	1	1.92	0.52 (0.01 - 2.90)	0	0.29	-
Ischaemic Heart Disease	**100**	**127.96**	**0.78 (0.64 - 0.95)**	**44**	**72.17**	**0.61 (0.44 - 0.82)**	6	10.44	0.57 (0.21 - 1.25)
Cerebrovascular	**18**	**33.25**	**0.54 (0.32 - 0.86)**	**9**	**14.56**	**0.62 (0.28 - 1.17)**	0	2.25	-
All Respiratory	**28**	**45.54**	**0.61 (0.41 - 0.89)**	**9**	**17.31**	**0.52 (0.24 - 0.99)**	1	2.75	0.36 (0.01 - 2.02)
COPD	18	27.45	0.66 (0.39 - 1.04)	3	7.49	0.40 (0.08 - 1.17)	1	0.85	1.18 (0.03 - 6.56)
All Digestive	20	21.70	0.92 (0.56 - 1.42)	**10**	**23.72**	**0.42 (0.20 - 0.78)**	0	4.02	-
Diseases of the Liver	13	11.72	1.11 (0.59 - 1.90)	**9**	**18.02**	**0.50 (0.23 - 0.95)**	0	3.06	-
All Injury & Trauma	**15**	**28.11**	**0.53 (0.30 - 0.88)**	**57**	**105.53**	**0.54 (0.41 - 0.70)**	16	38.42	0.42 (0.24 - 0.68)
All Accidents	**5**	**16.82**	**0.30 (0.10 - 0.69)**	**24**	**54.78**	**0.44 (0.28 - 0.65)**	**6**	**19.77**	**0.30 (0.11 - 0.66)**
Fire	0	0.48	-	0	1.31	-	1	0.30	3.33 (0.08 - 18.58)
Suicide	9	9.24	0.97 (0.45 - 1.85)	32	42.62	0.75 (0.51 - 1.06)	9	15.34	0.59 (0.27 - 1.11)
All Other Causes	43	53.58	0.80 (0.58 - 1.08)	**18**	**53.16**	**0.34 (0.20 - 0.54)**	**2**	**10.40**	**0.19 (0.02 - 0.69)**
Dementia & Alzheimers	9	9.16	0.98 (0.45 - 1.86)	0	1.31	-	0	0.14	-
Diabetes	16	15.73	1.02 (0.58 - 1.65)	7	9.42	0.74 (0.30 - 1.53)	0	1.52	-

* Statistically significantly reduced SMR results are in **blue**

Table 35: Standardised Mortality Ratios* and 95% confidence intervals for male part-time paid firefighter deaths to 30/11/2011 by era of first employment compared to the Australian population

Cause of Death Categories	Pre-1970 (N=367)			1970 - 1994 (N=3906)			Post 1995 (N=8387)		
	O	E	SMR (95%CI)	O	E	SMR (95%CI)	O	E	SMR (95%CI)
All Causes of Death Combined	**67**	**86.29**	**0.78 (0.60 - 0.99)**	**149**	**240.7**	**0.62 (0.52 - 0.73)**	**70**	**112.04**	**0.62 (0.49 - 0.79)**
All Malignancies	35	36.70	0.95 (0.66 - 1.33)	72	86.99	0.83 (0.65 - 1.04)	17	24.65	0.69 (0.40 - 1.10)
All Nervous System	1	2.34	0.43 (0.01 - 2.38)	2	6.33	0.32 (0.04 - 1.14)	1	3.37	0.30 (0.01 - 1.65)
All Circulatory	23	26.03	0.88 (0.56 - 1.33)	**30**	**59.22**	**0.51 (0.34 - 0.72)**	**7**	**19.24**	**0.36 (0.15 - 0.75)**
Hypertensive	0	0.49	-	3	1.05	2.84 (0.59 - 8.31)	0	0.32	-
Ischaemic Heart Disease	12	16.39	0.73 (0.38 - 1.28)	**21**	**38.53**	**0.54 (0.34 - 0.83)**	6	11.58	0.52 (0.19 - 1.13)
Cerebrovascular	5	4.35	1.15 (0.37 - 2.68)	3	8.14	0.37 (0.08 - 1.08)	1	2.48	0.40 (0.01 - 2.25)
All Respiratory	3	6.53	0.46 (0.09 - 1.34)	5	10.59	0.47 (0.15 - 1.01)	0	2.91	-
COPD	1	4.00	0.25 (0.01 - 1.39)	2	5.34	0.37 (0.05 - 1.35)	0	0.81	-
All Digestive	3	3.04	0.99 (0.20 - 2.88)	**4**	**11.25**	**0.36 (0.10 - 0.91)**	1	4.65	0.22 (0.01 - 1.20)
Diseases of the Liver	1	1.66	0.60 (0.02 - 3.36)	4	8.21	0.49 (0.13 - 1.25)	0	3.57	-
All Injury & Trauma	1	3.49	0.29 (0.01 - 1.60)	**25**	**40.86**	**0.61 (0.40 - 0.90)**	42	45.19	0.93 (0.67 - 1.26)
All Accidents	1	2.03	0.49 (0.01 - 2.74)	17	20.69	0.82 (0.48 - 1.32)	24	23.47	1.02 (0.66 - 1.52)
Fire	0	0.05	-	1	0.49	2.05 (0.05 - 11.43)	1	0.36	2.79 (0.07 - 15.56)
Suicide	0	1.17	-	**7**	**16.97**	**0.41 (0.17 - 0.85)**	15	17.94	0.84 (0.47 - 1.38)
All Other Causes	**1**	**8.16**	**0.12 (0.00 - 0.68)**	**11**	**25.45**	**0.43 (0.22 - 0.77)**	**2**	**12.03**	**0.17 (0.02 - 0.60)**
Dementia & Alzheimers	0	1.22	-	2	1.15	1.73 (0.21 - 6.27)	0	0.12	-
Diabetes	0	2.60	-	1	5.46	0.18 (0.00 - 1.02)	0	1.63	-

* Statistically significantly reduced SMR results are in **blue**

Table 36: Standardised Mortality Ratios* and 95% confidence intervals for male volunteer firefighter deaths to 30/11/2011 by era of first service compared to the Australian population

Cause of Death Categories	Pre-1970 (N=12476)			1970 - 1994 (N=48543)			1995+ (N=102,075)		
	O	E	SMR (95%CI)	O	E	SMR (95%CI)	O	E	SMR (95%CI)
All Causes of Death Combined	**1506**	**2775.31**	**0.54 (0.52 - 0.57)**	**1533**	**3125.91**	**0.49 (0.47 - 0.52)**	**1608**	**2775.7**	**0.58 (0.55 - 0.61)**
All Malignancies	**620**	**1051.33**	**0.59 (0.54 - 0.64)**	**648**	**1163.96**	**0.56 (0.51 - 0.60)**	**632**	**987.65**	**0.64 (0.59 - 0.69)**
All Nervous System	**37**	**88.38**	**0.42 (0.29 - 0.58)**	**46**	**92.50**	**0.50 (0.36 - 0.66)**	**38**	**85.77**	**0.44 (0.31 - 0.61)**
All Circulatory	**496**	**892.51**	**0.56 (0.51 - 0.61)**	**412**	**850.37**	**0.48 (0.44 - 0.53)**	**342**	**688.1**	**0.50 (0.45 - 0.55)**
Hypertensive	15	19.93	0.75 (0.42 - 1.24)	**6**	**17.17**	**0.35 (0.13 - 0.76)**	10	13.82	0.72 (0.35 - 1.33)
Ischaemic Heart Disease	**278**	**522.39**	**0.53 (0.47 - 0.60)**	**251**	**523.18**	**0.48 (0.42 - 0.54)**	**189**	**416.9**	**0.45 (0.39 - 0.52)**
Cerebrovascular	**75**	**173.72**	**0.43 (0.34 - 0.54)**	**56**	**139.76**	**0.40 (0.30 - 0.52)**	**58**	**111.26**	**0.52 (0.40 - 0.67)**
All Respiratory	**96**	**238.95**	**0.40 (0.33 - 0.49)**	**62**	**191.13**	**0.32 (0.25 - 0.42)**	**58**	**156.94**	**0.37 (0.28 - 0.48)**
COPD	**48**	**133.97**	**0.36 (0.26 - 0.48)**	**36**	**101.55**	**0.35 (0.25 - 0.49)**	**31**	**81.19**	**0.38 (0.26 - 0.54)**
All Digestive	**33**	**93.32**	**0.35 (0.24 - 0.50)**	**39**	**132.66**	**0.29 (0.21 - 0.40)**	**36**	**112.93**	**0.32 (0.22 - 0.44)**
Diseases of the Liver	**8**	**40.82**	**0.20 (0.08 - 0.39)**	**24**	**84.60**	**0.28 (0.18 - 0.42)**	**18**	**72.98**	**0.25 (0.15 - 0.39)**
All Injury & Trauma	**80**	**104.95**	**0.76 (0.60 - 0.95)**	**206**	**365.16**	**0.56 (0.49 - 0.65)**	**377**	**456.7**	**0.83 (0.74 - 0.91)**
All Accidents	56	66.84	0.84 (0.63 - 1.09)	**122**	**193.84**	**0.63 (0.52 - 0.75)**	**227**	246.99	0.92 (0.80 - 1.05)
Fire	4	1.58	2.53 (0.69 - 6.47)	9	4.35	2.07 (0.95 - 3.93)	6	4.44	1.35 (0.50 - 2.94)
Suicide	**18**	**29.24**	**0.62 (0.36 - 0.97)**	**66**	**141.57**	**0.47 (0.36 - 0.59)**	**120**	**169.9**	**0.71 (0.59 - 0.84)**
All Other Causes	**142**	**305.87**	**0.46 (0.39 - 0.55)**	**115**	**330.13**	**0.35 (0.29 - 0.42)**	**122**	**287.62**	**0.42 (0.35 - 0.51)**
Dementia & Alzheimers	**25**	**71.69**	**0.35 (0.23 - 0.51)**	**22**	**42.47**	**0.52 (0.32 - 0.78)**	**10**	**33.53**	**0.30 (0.14 - 0.55)**
Diabetes	**38**	**83.13**	**0.46 (0.32 - 0.63)**	**23**	**81.30**	**0.28 (0.18 - 0.42)**	**25**	**68.39**	**0.37 (0.24 - 0.54)**

* Statistically significantly reduced SMR results are in **blue**

Table 37: Standardised Mortality Ratios* and 95% confidence intervals for female volunteer firefighter deaths to 30/11/2011 by era of first service compared to the Australian population

Cause of Death Categories	Pre-1970 (N=370)			1970 - 1994 (N=6209)			1995+ (N=31,383)		
	O	E	SMR (95%CI)	O	E	SMR (95%CI)	O	E	SMR (95%CI)
All Causes of Death Combined	39	52.37	0.74 (0.53 - 1.02)	**177**	**297.76**	**0.59 (0.51 - 0.69)**	**310**	**472.80**	**0.66 (0.58 - 0.73)**
All Malignancies	12	18.17	0.66 (0.34 - 1.15)	**99**	**129.15**	**0.77 (0.62 - 0.93)**	**157**	**211.81**	**0.74 (0.63 - 0.87)**
All Nervous System	1	2.16	0.46 (0.01 - 2.58)	**4**	**11.44**	**0.35 (0.10 - 0.90)**	**6**	**18.18**	**0.33 (0.12 - 0.72)**
All Circulatory	17	16.86	1.01 (0.59 - 1.61)	**34**	**71.92**	**0.47 (0.33 - 0.66)**	**49**	**95.39**	**0.51 (0.38 - 0.68)**
Hypertensive	0	0.65	-	1	2.51	0.40 (0.01 - 2.22)	1	3.10	0.32 (0.01 - 1.80)
Ischaemic Heart Disease	6	7.68	0.78 (0.29 - 1.70)	**9**	**32.23**	**0.28 (0.13 - 0.53)**	**22**	**40.93**	**0.54 (0.34 - 0.81)**
Cerebrovascular	4	4.65	0.86 (0.23 - 2.20)	**9**	**19.43**	**0.46 (0.21 - 0.88)**	**11**	**25.59**	**0.43 (0.21 - 0.77)**
All Respiratory	1	4.42	0.23 (0.01 - 1.26)	**7**	**21.46**	**0.33 (0.13 - 0.67)**	**13**	**30.17**	**0.43 (0.23 - 0.74)**
COPD	1	2.24	0.45 (0.01 - 2.49)	2	11.26	0.18 (0.02 - 0.64)	8	15.20	0.53 (0.23 - 1.04)
All Digestive	1	1.81	0.55 (0.01 - 3.09)	5	10.70	0.47 (0.15 - 1.09)	**9**	**17.4**	**0.52 (0.24 - 0.98)**
Diseases of the Liver	1	0.43	2.30 (0.06 - 12.82)	2	4.47	0.45 (0.05 - 1.62)	**2**	**8.84**	**0.23 (0.03 - 0.82)**
All Injury & Trauma	1	1.54	0.65 (0.02 - 3.63)	14	16.45	0.85 (0.47 - 1.43)	51	43.83	1.16 (0.87 - 1.53)
All Accidents	1	1.15	0.87 (0.02 - 4.86)	11	9.82	1.12 (0.56 - 2.01)	**35**	**24.14**	**1.45 (1.01 - 2.02)**
Fire	0	0.04	-	0	0.56	-	2	1.33	1.50 (0.18 - 5.43)
Suicide	0	0.23	-	1	4.73	0.21 (0.01 - 1.18)	13	14.10	0.92 (0.49 - 1.58)
All Other Causes	6	7.42	0.81 (0.30 - 1.76)	**13**	**36.64**	**0.35 (0.19 - 0.61)**	**25**	**56.01**	**0.45 (0.29 - 0.66)**
Dementia & Alzheimers	3	2.29	1.31 (0.27 - 3.83)	5	8.13	0.61 (0.20 - 1.44)	5	9.29	0.54 (0.17 - 1.26)
Diabetes	2	1.56	1.28 (0.16 - 4.64)	4	7.97	0.50 (0.14 - 1.29)	5	11.43	0.44 (0.14 - 1.02)

* Statistically significantly elevated SMR results are in **red**, statistically significantly reduced SMR results are in **blue**

Table 38: Standardised Cancer Incidence Ratios* and 95% confidence intervals for male career full-time firefighters to 31/12/2010 by era compared to the Australian population

Cancer Categories	Pre-1970			1970 - 1994			1995+		
	O	E	SIR (95%CI)	O	E	SIR (95%CI)	O	E	SIR (95%CI)
All Malignancies	566	529.16	1.07 (0.98 - 1.16)	545	506.09	1.08 (0.99 - 1.17)	97	85.79	1.13 (0.92 - 1.38)
Lip, Oral Cavity & Pharynx	27	21.25	1.27 (0.84 - 1.85)	24	31.32	0.77 (0.49 - 1.14)	4	5.55	0.72 (0.20 - 1.84)
Lip	8	6.77	1.18 (0.51 - 2.33)	13	11.52	1.13 (0.60 - 1.93)	2	2.45	0.82 (0.10 - 2.95)
Digestive Organs	129	118.85	1.09 (0.91 - 1.29)	88	97.28	0.90 (0.73 - 1.11)	13	13.95	0.93 (0.50 - 1.59)
Oesophagus	8	7.99	1.00 (0.43 - 1.97)	4	6.86	0.58 (0.16 - 1.49)	0	0.94	-
Stomach	17	13.08	1.30 (0.76 - 2.08)	6	10.05	0.60 (0.22 - 1.30)	1	1.41	0.71 (0.02 - 3.96)
Colorectal	82	76.27	1.08 (0.86 - 1.33)	67	59.80	1.12 (0.87 - 1.42)	8	8.59	0.93 (0.40 - 1.84)
Colon	51	45.03	1.13 (0.84 - 1.49)	38	31.93	1.19 (0.84 - 1.63)	3	4.52	0.66 (0.14 - 1.94)
Rectum	26	22.68	1.15 (0.75 - 1.68)	25	20.68	1.21 (0.78 - 1.78)	4	3.07	1.30 (0.36 - 3.34)
Liver	6	6.35	0.95 (0.35 - 2.06)	**1**	**7.81**	**0.13 (0.00 - 0.71)**	1	1.19	0.84 (0.02 - 4.70)
Pancreas	12	10.81	1.11 (0.57 - 1.94)	7	8.58	0.82 (0.33 - 1.68)	3	1.17	2.57 (0.53 - 7.51)
Respiratory	61	73.75	0.83 (0.63 - 1.06)	34	43.80	0.78 (0.54 - 1.08)	5	5.40	0.93 (0.30 - 2.16)
Larynx	5	6.99	0.72 (0.23 - 1.67)	5	5.16	0.97 (0.31 - 2.26)	1	0.58	1.71 (0.04 - 9.53)
Lung	54	65.42	0.83 (0.62 - 1.08)	28	36.74	0.76 (0.51 - 1.10)	4	4.41	0.91 (0.25 - 2.32)
Melanoma	**75**	**47.58**	**1.58 (1.24 - 1.98)**	**108**	**80.23**	**1.35 (1.10 - 1.63)**	**26**	**16.50**	**1.58 (1.03 - 2.31)**
Mesothelioma	3	5.12	0.59 (0.12 - 1.71)	6	2.88	2.08 (0.76 - 4.53)	2	0.30	6.65 (0.81 - 24.02)
Male Reproductive	170	151.45	1.12 (0.96 - 1.30)	**161**	**126.53**	**1.27 (1.08 - 1.48)**	26	20.17	1.29 (0.84 - 1.89)
Prostate	**169**	**141.63**	**1.19 (1.02 - 1.39)**	**141**	**109.14**	**1.29 (1.09 - 1.52)**	15	13.16	1.14 (0.64 - 1.88)
Testis	0	1.16	-	20	13.70	1.46 (0.89 - 2.25)	11	6.61	1.66 (0.83 - 2.98)
Urinary tract	30	32.62	0.92 (0.62 - 1.31)	28	27.99	1.00 (0.66 - 1.45)	1	4.30	0.23 (0.01 - 1.30)
Kidney	17	13.51	1.26 (0.73 - 2.01)	15	17.52	0.86 (0.48 - 1.41)	1	3.06	0.33 (0.01 - 1.82)
Bladder	11	16.88	0.65 (0.33 - 1.17)	12	9.19	1.31 (0.67 - 2.28)	0	1.07	-
Brain & Other CNS	6	7.30	0.82 (0.30 - 1.79)	8	11.90	0.67 (0.29 - 1.32)	3	2.68	1.12 (0.23 - 3.27)
Brain	5	7.06	0.71 (0.23 - 1.65)	8	11.35	0.70 (0.30 - 1.39)	3	2.55	1.18 (0.24 - 3.44)
Thyroid & Other Endocrine	2	2.55	0.78 (0.09 - 2.83)	7	7.32	0.96 (0.38 - 1.97)	4	2.17	1.85 (0.50 - 4.72)
Thyroid	2	2.29	0.87 (0.11 - 3.15)	7	6.74	1.04 (0.42 - 2.14)	4	2.01	1.99 (0.54 - 5.08)

Cancer Categories	Pre-1970			1970 - 1994			1995+		
	O	E	SIR (95%CI)	O	E	SIR (95%CI)	O	E	SIR (95%CI)
Unknown Site	12	15.31	0.78 (0.40 - 1.37)	14	10.57	1.33 (0.72 - 2.22)	1	1.41	0.71 (0.02 - 3.94)
Lympho-haematopoetic	41	47.56	0.86 (0.62 - 1.17)	58	55.46	1.05 (0.79 - 1.35)	10	11.23	0.89 (0.43 - 1.64)
Hodgkin Disease	1	1.16	0.86 (0.02 - 4.81)	5	3.93	1.27 (0.41 - 2.97)	0	1.47	-
Non-Hodgkin Lymphoma	15	18.30	0.82 (0.46 - 1.35)	25	25.00	1.00 (0.65 - 1.48)	7	4.73	1.48 (0.59 - 3.05)
Follicular-NHL	5	3.78	1.32 (0.43 - 3.09)	9	6.94	1.30 (0.59 - 2.46)	2	1.29	1.55 (0.19 - 5.60)
Diffuse-NHL	8	9.06	0.88 (0.38 - 1.74)	10	11.39	0.88 (0.42 - 1.62)	4	2.21	1.81 (0.49 - 4.64)
Myeloma	9	6.53	1.38 (0.63 - 2.62)	5	5.80	0.86 (0.28 - 2.01)	1	0.78	1.27 (0.03 - 7.10)
Leukaemia	10	13.42	0.75 (0.36 - 1.37)	16	14.18	1.13 (0.64 - 1.83)	2	2.91	0.69 (0.08 - 2.48)
MDS	3	2.77	1.08 (0.22 - 3.16)	1	1.37	0.73 (0.02 - 4.06)	0	0.26	-
All Other Cancers	10	5.81	1.72 (0.83 - 3.17)	9	10.81	0.83 (0.38 - 1.58)	2	2.14	0.93 (0.11 - 3.38)
Male Breast	3	0.96	3.13 (0.64 - 9.14)	2	0.92	2.18 (0.26 - 7.89)	0	0.13	-

* Statistically significantly elevated SIR results are in **red**, statistically significantly reduced SIR results are in **blue**

Table 39: Standardised Cancer Incidence Ratios* and 95% confidence intervals for male part-time paid firefighters to 31/12/2010 by era compared to the Australian population

Cancer Categories	Pre-1970			1970 - 1994			1995+		
	O	E	SIR (95%CI)	O	E	SIR (95%CI)	O	E	SIR (95%CI)
All Malignancies	104	88.06	1.18 (0.96 - 1.43)	286	260.31	1.10 (0.98 - 1.23)	95	90.46	1.05 (0.85 - 1.28)
Lip, Oral Cavity & Pharynx	2	3.14	0.64 (0.08 - 2.30)	12	14.31	0.84 (0.43 - 1.47)	7	6.13	1.14 (0.46 - 2.35)
Lip	0	0.96	-	7	5.00	1.40 (0.56 - 2.88)	4	2.69	1.49 (0.41 - 3.81)
Digestive Organs	17	19.40	0.88 (0.51 - 1.40)	56	51.74	1.08 (0.82 - 1.41)	12	14.53	0.83 (0.43 - 1.44)
Oesophagus	2	1.29	1.55 (0.19 - 5.59)	3	3.63	0.83 (0.17 - 2.42)	0	0.97	-
Stomach	2	2.00	1.00 (0.12 - 3.62)	5	5.24	0.95 (0.31 - 2.23)	2	1.49	1.34 (0.16 - 4.85)
Colorectal	9	12.55	0.72 (0.33 - 1.36)	39	32.34	1.21 (0.86 - 1.65)	9	8.85	1.02 (0.47 - 1.93)
Colon	5	7.39	0.68 (0.22 - 1.58)	17	17.61	0.97 (0.56 - 1.55)	5	4.61	1.08 (0.35 - 2.53)
Rectum	2	3.74	0.53 (0.06 - 1.93)	16	10.89	1.47 (0.84 - 2.39)	3	3.18	0.94 (0.19 - 2.75)
Liver	0	1.12	-	4	3.80	1.05 (0.29 - 2.69)	0	1.31	-
Pancreas	3	1.75	1.71 (0.35 - 5.00)	4	4.60	0.87 (0.24 - 2.23)	0	1.21	-
Respiratory	**1**	**11.39**	**0.09 (0.00 - 0.49)**	15	24.82	0.60 (0.34 - 1.00)	1	5.46	0.18 (0.00 - 1.02)
Larynx	0	1.03	-	1	2.78	0.36 (0.01 - 2.00)	0	0.61	-
Lung	**1**	**10.16**	**0.10 (0.00 - 0.55)**	13	21.17	0.61 (0.33 - 1.05)	1	4.40	0.23 (0.01 - 1.27)
Melanoma	**18**	**7.74**	**2.32 (1.38 - 3.67)**	45	36.49	1.23 (0.90 - 1.65)	26	18.15	1.43 (0.94 - 2.10)
Mesothelioma	1	0.87	1.14 (0.03 - 6.37)	2	1.75	1.15 (0.14 - 4.14)	1	0.29	3.49 (0.09 - 19.46)
Male Reproductive	37	27.90	1.33 (0.93 - 1.83)	**101**	**71.12**	**1.42 (1.16 - 1.73)**	29	19.76	1.47 (0.98 - 2.11)
Prostate	**37**	**25.91**	**1.43 (1.01 - 1.97)**	**95**	**63.14**	**1.50 (1.22 - 1.84)**	**21**	**11.96**	**1.76 (1.09 - 2.68)**
Testis	0	0.13	-	4	5.37	0.74 (0.20 - 1.91)	8	7.36	1.09 (0.47 - 2.14)
Urinary tract	7	5.10	1.37 (0.55 - 2.83)	16	14.44	1.11 (0.63 - 1.80)	2	4.53	0.44 (0.05 - 1.60)
Kidney	4	2.27	1.77 (0.48 - 4.52)	13	8.59	1.51 (0.81 - 2.59)	2	3.28	0.61 (0.07 - 2.21)
Bladder	2	2.48	0.81 (0.10 - 2.91)	3	5.13	0.58 (0.12 - 1.71)	0	1.09	-
Brain & Other CNS	**5**	**1.14**	**4.40 (1.43 - 10.26)**	6	5.40	1.11 (0.41 - 2.42)	2	2.94	0.68 (0.08 - 2.46)
Brain	**5**	**1.10**	**4.54 (1.47 - 10.59)**	6	5.17	1.16 (0.43 - 2.53)	1	2.79	0.36 (0.01 - 2.00)

Cancer Categories	Pre-1970			1970 - 1994			1995+		
	O	E	SIR (95%CI)	O	E	SIR (95%CI)	O	E	SIR (95%CI)
Thyroid & Other Endocrine	**3**	**0.43**	**7.02 (1.45 - 20.51)**	4	3.22	1.24 (0.34 - 3.18)	0	2.38	-
Thyroid	**3**	**0.39**	**7.78 (1.60 - 22.74)**	4	2.97	1.35 (0.37 - 3.45)	0	2.21	-
Unknown Site	1	2.25	0.44 (0.01 - 2.48)	4	5.55	0.72 (0.20 - 1.84)	1	1.51	0.66 (0.02 - 3.68)
Lympho-haematopoetic	11	7.80	1.41 (0.70 - 2.52)	21	27.00	0.78 (0.48 - 1.19)	11	12.36	0.89 (0.44 - 1.59)
Hodgkin Disease	0	0.16	-	3	1.59	1.89 (0.39 - 5.53)	1	1.77	0.57 (0.01 - 3.15)
Non-Hodgkin Lymphoma	5	2.98	1.68 (0.54 - 3.91)	11	11.74	0.94 (0.47 - 1.68)	3	5.21	0.58 (0.12 - 1.68)
Follicular-NHL	1	0.63	1.59 (0.04 - 8.87)	5	3.16	1.58 (0.51 - 3.69)	1	1.40	0.71 (0.02 - 3.97)
Diffuse-NHL	3	1.49	2.01 (0.41 - 5.88)	4	5.46	0.73 (0.20 - 1.88)	2	2.43	0.82 (0.10 - 2.97)
Myeloma	2	1.07	1.86 (0.23 - 6.73)	0	3.04	-	1	0.83	1.21 (0.03 - 6.74)
Leukaemia	4	2.15	1.86 (0.51 - 4.75)	6	7.06	0.85 (0.31 - 1.85)	5	3.18	1.57 (0.51 - 3.66)
MDS	0	0.49	-	0	0.86	-	0	0.24	-
All Other Cancers	1	0.90	1.12 (0.03 - 6.21)	4	4.48	0.89 (0.24 - 2.29)	3	2.41	1.24 (0.26 - 3.64)
Male Breast	0	0.16	-	1	0.47	2.14 (0.05 - 11.92)	0	0.14	-

* Statistically significantly elevated SIR results are in **red**, statistically significantly reduced SIR results are in **blue**

Table 40: Standardised Cancer Incidence Ratios* and 95% confidence intervals for male volunteer firefighters to 31/12/2010 by era compared to the Australian population

Cancer Categories	Pre-1970			1970 - 1994			1995+		
	O	E	SIR (95%CI)	O	E	SIR (95%CI)	O	E	SIR (95%CI)
All Malignancies	**1994**	**2361.09**	**0.84 (0.81 - 0.88)**	**2713**	**3190.26**	**0.85 (0.82 - 0.88)**	**2350**	**2664.83**	**0.88 (0.85 - 0.92)**
Lip, Oral Cavity & Pharynx	61	76.34	0.80 (0.61 - 1.03)	**99**	**147.14**	**0.67 (0.55 - 0.82)**	**85**	**119.32**	**0.71 (0.57 - 0.88)**
Lip	**44**	**22.76**	**1.93 (1.40 - 2.60)**	48	47.18	1.02 (0.75 - 1.35)	33	38.73	0.85 (0.59 - 1.20)
Digestive Organs	**404**	**512.44**	**0.79 (0.71 - 0.87)**	**477**	**648.93**	**0.74 (0.67 - 0.80)**	**416**	**517.91**	**0.80 (0.73 - 0.88)**
Oesophagus	**19**	**35.19**	**0.54 (0.33 - 0.84)**	35	45.87	0.76 (0.53 - 1.06)	**23**	**36.57**	**0.63 (0.40 - 0.94)**
Stomach	**38**	**52.72**	**0.72 (0.51 - 0.99)**	**46**	**64.23**	**0.72 (0.52 - 0.96)**	**32**	**50.03**	**0.64 (0.44 - 0.90)**
Colorectal	**283**	**325.32**	**0.87 (0.77 - 0.98)**	**336**	**404.55**	**0.83 (0.74 - 0.92)**	**278**	**322.75**	**0.86 (0.76 - 0.97)**
Colon	175	195.18	0.90 (0.77 - 1.04)	**194**	**227.43**	**0.85 (0.74 - 0.98)**	157	181.30	0.87 (0.74 - 1.01)
Rectum	87	96.30	0.90 (0.72 - 1.11)	114	132.17	0.86 (0.71 - 1.04)	100	106.01	0.94 (0.77 - 1.15)
Liver	**9**	**31.26**	**0.29 (0.13 - 0.55)**	**11**	**47.98**	**0.23 (0.11 - 0.41)**	**19**	**39.37**	**0.48 (0.29 - 0.75)**
Pancreas	41	48.77	0.84 (0.60 - 1.14)	**35**	**59.94**	**0.58 (0.41 - 0.81)**	40	47.96	0.83 (0.60 - 1.14)
Respiratory	**118**	**291.20**	**0.41 (0.34 - 0.49)**	**163**	**324.42**	**0.50 (0.43 - 0.59)**	**148**	**254.12**	**0.58 (0.49 - 0.68)**
Larynx	**4**	**24.16**	**0.17 (0.05 - 0.42)**	**16**	**32.00**	**0.50 (0.29 - 0.81)**	16	24.58	0.65 (0.37 - 1.06)
Lung	**109**	**261.77**	**0.42 (0.34 - 0.50)**	**141**	**283.18**	**0.50 (0.42 - 0.59)**	**121**	**221.37**	**0.55 (0.45 - 0.65)**
Melanoma	**168**	**209.39**	**0.80 (0.69 - 0.93)**	381	382.85	1.00 (0.90 - 1.10)	**363**	**323.91**	**1.12 (1.01 - 1.24)**
Mesothelioma	**7**	**23.04**	**0.30 (0.12 - 0.63)**	17	23.74	0.72 (0.42 - 1.15)	18	18.39	0.98 (0.58 - 1.55)
Male Reproductive	**860**	**760.77**	**1.13 (1.06 - 1.21)**	**1073**	**963.10**	**1.11 (1.05 - 1.18)**	830	840.30	0.99 (0.92 - 1.06)
Prostate	**851**	**722.35**	**1.18 (1.10 - 1.26)**	**1022**	**887.68**	**1.15 (1.08 - 1.22)**	782	758.24	1.03 (0.96 - 1.11)
Testis	7	3.52	1.99 (0.80 - 4.10)	47	43.74	1.07 (0.79 - 1.43)	45	59.88	0.75 (0.55 - 1.01)
Urinary tract	**101**	**139.70**	**0.72 (0.59 - 0.88)**	**123**	**179.04**	**0.69 (0.57 - 0.82)**	**110**	**142.74**	**0.77 (0.63 - 0.93)**
Kidney	56	60.34	0.93 (0.70 - 1.21)	**74**	**98.62**	**0.75 (0.59 - 0.94)**	66	81.00	0.81 (0.63 - 1.04)
Bladder	**38**	**70.11**	**0.54 (0.38 - 0.74)**	**39**	**70.87**	**0.55 (0.39 - 0.75)**	40	54.25	0.74 (0.53 - 1.00)
Brain & Other CNS	25	29.06	0.86 (0.56 - 1.27)	**34**	**56.03**	**0.61 (0.42 - 0.85)**	57	49.33	1.16 (0.88 - 1.50)
Brain	25	28.14	0.89 (0.57 - 1.31)	**33**	**53.84**	**0.61 (0.42 - 0.86)**	56	47.28	1.18 (0.89 - 1.54)

Cancer Categories	Pre-1970			1970 - 1994			1995+		
	O	E	SIR (95%CI)	O	E	SIR (95%CI)	O	E	SIR (95%CI)
Thyroid & Other Endocrine	10	11.74	0.85 (0.41 - 1.57)	**21**	**32.79**	**0.64 (0.40 - 0.98)**	31	31.71	0.98 (0.66 - 1.39)
Thyroid	10	10.70	0.93 (0.45 - 1.72)	20	30.36	0.66 (0.40 - 1.02)	28	29.24	0.96 (0.64 - 1.38)
Unknown Site	**32**	**61.86**	**0.52 (0.35 - 0.73)**	**42**	**69.66**	**0.60 (0.43 - 0.81)**	**27**	**52.73**	**0.51 (0.34 - 0.74)**
Lympho-haematopoetic	**177**	**222.12**	**0.80 (0.68 - 0.92)**	**249**	**319.40**	**0.78 (0.69 - 0.88)**	**237**	**275.49**	**0.86 (0.75 - 0.98)**
Hodgkin Disease	6	4.30	1.40 (0.51 - 3.04)	12	14.65	0.82 (0.42 - 1.43)	15	19.71	0.76 (0.43 - 1.25)
Non-Hodgkin Lymphoma	65	81.01	0.80 (0.62 - 1.02)	108	130.57	0.83 (0.68 - 1.00)	94	109.96	0.85 (0.69 - 1.05)
Follicular-NHL	17	16.96	1.00 (0.58 - 1.60)	35	33.95	1.03 (0.72 - 1.43)	22	28.19	0.78 (0.49 - 1.18)
Diffuse-NHL	31	39.86	0.78 (0.53 - 1.10)	50	61.08	0.82 (0.61 - 1.08)	45	52.16	0.86 (0.63 - 1.15)
Myeloma	27	30.23	0.89 (0.59 - 1.30)	**23**	**38.45**	**0.60 (0.38 - 0.90)**	24	30.46	0.79 (0.50 - 1.17)
Leukaemia	50	60.35	0.83 (0.61 - 1.09)	69	83.87	0.82 (0.64 - 1.04)	75	72.29	1.04 (0.82 - 1.30)
MDS	12	19.09	0.63 (0.32 - 1.10)	13	17.37	0.75 (0.40 - 1.28)	17	15.29	1.11 (0.65 - 1.78)
All Other Cancers	31	23.44	1.32 (0.90 - 1.88)	34	43.15	0.79 (0.55 - 1.10)	28	38.88	0.72 (0.48 - 1.04)
Male Breast	6	4.24	1.41 (0.52 - 3.08)	5	5.68	0.88 (0.29 - 2.05)	1	4.54	0.22 (0.01 - 1.23)

* Statistically significantly elevated SIR results are in **red**, statistically significantly reduced SIR results are in **blue**

Table 41: Standardised Cancer Incidence Ratios* and 95% confidence intervals for female volunteer firefighters to 31/12/2010 by era compared to the Australian population

Cancer Categories	Pre-1970			1970 - 1994			1995+		
	O	E	SIR (95%CI)	O	E	SIR (95%CI)	O	E	SIR (95%CI)
All Malignancies	29	38.93	0.74 (0.50 - 1.07)	352	372.14	0.95 (0.85 - 1.05)	646	650.17	0.99 (0.92 - 1.07)
Lip, Oral Cavity & Pharynx	0	0.73	-	6	6.95	0.86 (0.32 - 1.88)	10	12.02	0.83 (0.40 - 1.53)
Lip	0	0.21	-	3	1.85	1.62 (0.33 - 4.73)	3	3.03	0.99 (0.20 - 2.89)
Digestive Organs	5	8.52	0.59 (0.19 - 1.37)	55	61.97	0.89 (0.67 - 1.16)	103	94.38	1.09 (0.89 - 1.32)
Oesophagus	0	0.34	-	1	2.13	0.47 (0.01 - 2.62)	3	2.93	1.02 (0.21 - 2.99)
Stomach	0	0.59	-	1	4.35	0.23 (0.01 - 1.28)	3	6.74	0.44 (0.09 - 1.30)
Colorectal	5	5.86	0.85 (0.28 - 1.99)	43	43.51	0.99 (0.72 - 1.33)	83	66.74	1.24 (0.99 - 1.54)
Colon	4	4.04	0.99 (0.27 - 2.53)	26	28.13	0.92 (0.60 - 1.35)	51	42.01	1.21 (0.90 - 1.60)
Rectum	1	1.23	0.81 (0.02 - 4.52)	12	10.32	1.16 (0.60 - 2.03)	25	16.63	1.50 (0.97 - 2.22)
Liver	0	0.28	-	1	2.10	0.48 (0.01 - 2.66)	0	3.38	-
Pancreas	0	0.99	-	5	6.46	0.77 (0.25 - 1.81)	8	9.43	0.85 (0.37 - 1.67)
Respiratory	2	3.73	0.54 (0.06 - 1.94)	19	27.65	0.69 (0.41 - 1.07)	45	41.94	1.07 (0.78 - 1.44)
Larynx	0	0.07	-	0	0.52	-	0	0.79	-
Lung	2	3.60	0.56 (0.07 - 2.01)	18	26.45	0.68 (0.40 - 1.08)	45	39.87	1.13 (0.82 - 1.51)
Melanoma	1	3.15	0.32 (0.01 - 1.77)	46	38.30	1.20 (0.88 - 1.60)	**100**	**76.61**	**1.31 (1.06 - 1.59)**
Mesothelioma	1	0.10	9.60 (0.24 - 53.49)	0	0.78	-	2	1.16	1.72 (0.21 - 6.21)
Breast	11	10.91	1.01 (0.50 - 1.80)	127	127.31	1.00 (0.83 - 1.19)	211	226.20	0.93 (0.81 - 1.07)
Female-Reproductive	6	3.74	1.60 (0.59 - 3.49)	33	38.17	0.86 (0.60 - 1.21)	**49**	**68.36**	**0.72 (0.53 - 0.95)**
Cervix	1	0.40	2.52 (0.06 - 14.05)	3	6.68	0.45 (0.09 - 1.31)	8	15.43	0.52 (0.22 - 1.02)
Urinary tract	1	1.45	0.69 (0.02 - 3.85)	8	10.93	0.73 (0.32 - 1.44)	14	17.08	0.82 (0.45 - 1.38)
Kidney	1	0.76	1.31 (0.03 - 7.30)	6	6.89	0.87 (0.32 - 1.90)	12	11.70	1.03 (0.53 - 1.79)
Bladder	0	0.50	-	1	3.02	0.33 (0.01 - 1.85)	1	4.09	0.24 (0.01 - 1.36)
Brain & Other CNS	0	0.50	-	8	4.98	1.61 (0.69 - 3.17)	7	9.51	0.74 (0.30 - 1.52)
Brain	0	0.47	-	8	4.69	1.07 (0.74 - 3.36)	5	8.96	0.56 (0.18 - 1.30)

Cancer Categories	Pre-1970			1970 - 1994			1995+		
	O	E	SIR (95%CI)	O	E	SIR (95%CI)	O	E	SIR (95%CI)
Thyroid & Other Endocrine	0	0.63	-	10	11.64	0.86 (0.41 - 1.58)	31	28.71	1.08 (0.73 - 1.53)
Thyroid	0	0.61	-	10	11.35	0.88 (0.42 - 1.62)	29	28.08	1.03 (0.69 - 1.48)
Unknown Site	0	1.19	-	7	7.63	0.92 (0.37 - 1.89)	8	10.71	0.75 (0.32 - 1.47)
Lympho-haematopoetic	1	3.84	0.26 (0.01 - 1.45)	27	31.59	0.85 (0.56 - 1.24)	62	55.32	1.12 (0.86 - 1.44)
Hodgkin Disease	0	0.08	-	2	1.30	1.53 (0.19 - 5.54)	6	4.60	1.30 (0.48 - 2.84)
Non-Hodgkin Lymphoma	0	1.57	-	11	13.52	0.81 (0.41 - 1.46)	27	22.72	1.19 (0.78 - 1.73)
Follicular-NHL	0	0.54	-	6	3.88	1.55 (0.57 - 3.36)	7	5.83	1.20 (0.48 - 2.47)
Diffuse-NHL	0	0.38	-	2	3.98	0.50 (0.06 - 1.82)	12	6.92	1.73 (0.90 - 3.03)
Myeloma	0	0.71	-	5	5.65	0.88 (0.29 - 2.07)	10	9.31	1.07 (0.52 - 1.98)
Leukaemia	1	0.88	1.14 (0.03 - 6.33)	6	7.28	0.82 (0.30 - 1.79)	16	12.77	1.25 (0.72 - 2.04)
MDS	0	0.28	-	2	1.66	1.21 (0.15 - 4.36)	1	2.62	0.38 (0.01 - 2.13)
All Other Cancers	1	0.44	2.28 (0.06 - 12.69)	6	4.24	1.41 (0.52 - 3.08)	4	8.17	0.49 (0.13 - 1.25)

* Statistically significantly elevated SIR results are in **red**, statistically significantly reduced SIR results are in **blue**

Table 42: Standardised Mortality Ratios* and 95% confidence intervals for male career full-time firefighter deaths to 30/11/2011 with 1985 cut point compared to the Australian population

Cause of Death Categories	Pre-1985 (N=549)			Post-1985 (N=16,845)		
	O	E	SMR (95%CI)	O	E	SMR (95%CI)
All Causes of Death Combined	211	209.14	1.01 (0.88 - 1.15)	**569**	**960.81**	**0.59 (0.54 - 0.64)**
All Malignancies	72	71.87	1.00 (0.78 - 1.26)	**257**	**335.90**	**0.77 (0.67 - 0.86)**
All Nervous System	5	5.31	0.94 (0.31 - 2.20)	**15**	**24.87**	**0.60 (0.34 - 0.99)**
All Circulatory	67	77.00	0.87 (0.67 - 1.11)	**142**	**250.74**	**0.57 (0.48 - 0.67)**
Hypertensive	1	1.50	0.67 (0.02 - 3.72)	4	4.45	0.90 (0.24 - 2.30)
Ischaemic Heart Disease	55	48.45	1.14 (0.86 - 1.48)	**95**	**162.11**	**0.59 (0.47 - 0.72)**
Cerebrovascular	**5**	**13.66**	**0.37 (0.12 - 0.85)**	**22**	**36.40**	**0.60 (0.38 - 0.91)**
All Respiratory	17	17.63	0.96 (0.56 - 1.54)	**21**	**47.97**	**0.44 (0.27 - 0.67)**
COPD	13	10.60	1.23 (0.65 - 2.10)	**9**	**25.19**	**0.36 (0.16 - 0.68)**
All Digestive	11	7.24	1.52 (0.76 - 2.72)	**19**	**42.20**	**0.45 (0.27 - 0.70)**
Diseases of the Liver	6	3.42	1.75 (0.64 - 3.81)	**16**	**29.38**	**0.54 (0.31 - 0.88)**
All Injury & Trauma	16	10.68	1.50 (0.86 - 2.43)	**72**	**161.38**	**0.45 (0.35 - 0.56)**
All Accidents	6	6.61	0.91 (0.33 - 1.98)	**29**	**84.76**	**0.34 (0.23 - 0.49)**
Fire	0	0.18	-	1	1.90	0.53 (0.01 - 2.93)
Suicide	**9**	**3.33**	**2.70 (1.23 - 5.13)**	**41**	**63.87**	**0.64 (0.46 - 0.87)**
All Other Causes	23	19.40	1.19 (0.75 - 1.78)	**40**	**97.74**	**0.41 (0.29 - 0.56)**
Dementia & Alzheimers	2	4.15	0.48 (0.06 - 1.74)	7	6.46	1.08 (0.44 - 2.23)
Diabetes	8	5.16	1.55 (0.67 - 3.05)	15	21.50	0.70 (0.39 - 1.15)

* Statistically significantly elevated SMR results are in **red**, statistically significantly reduced SMR results are in **blue**

Table 43: Standardised Cancer Incidence Ratios* and 95% confidence intervals for male career full-time firefighters to 31/12/2010 with 1985 cut point compared to the Australian population

Cancer Categories	Pre-1985 (N=549)			Post-1985 (N=16,845)		
	O	E	SIR (95%CI)	O	E	SIR (95%CI)
All Malignancies	154	148.87	1.03 (0.88 - 1.21)	**1054**	**972.17**	**1.08 (1.02 - 1.15)**
Lip, Oral Cavity & Pharynx	7	6.06	1.15 (0.46 - 2.38)	48	52.06	0.92 (0.68 - 1.22)
Lip	0	2.06	-	23	18.68	1.23 (0.78 - 1.85)
Digestive Organs	40	33.83	1.18 (0.84 - 1.61)	190	196.24	0.97 (0.84 - 1.12)
Oesophagus	4	2.29	1.75 (0.48 - 4.47)	8	13.50	0.59 (0.26 - 1.17)
Stomach	**9**	**4.06**	**2.21 (1.01 - 4.20)**	15	20.48	0.73 (0.41 - 1.21)
Colorectal	23	21.30	1.08 (0.68 - 1.62)	134	123.35	1.09 (0.91 - 1.29)
Colon	13	12.76	1.02 (0.54 - 1.74)	79	68.72	1.15 (0.91 - 1.43)
Rectum	10	6.14	1.63 (0.78 - 2.99)	45	40.29	1.12 (0.81 - 1.49)
Liver	0	1.75	-	8	13.59	0.59 (0.25 - 1.16)
Pancreas	3	3.16	0.95 (0.20 - 2.78)	19	17.39	1.09 (0.66 - 1.71)
Respiratory	19	22.44	0.85 (0.51 - 1.32)	81	100.51	0.81 (0.64 - 1.00)
Larynx	1	1.99	0.50 (0.01 - 2.80)	10	10.75	0.93 (0.45 - 1.71)
Lung	18	20.05	0.90 (0.53 - 1.42)	68	86.52	0.79 (0.61 - 1.00)
Melanoma	17	13.29	1.28 (0.74 - 2.05)	**192**	**131.02**	**1.47 (1.27 - 1.69)**
Mesothelioma	2	1.40	1.43 (0.17 - 5.16)	9	6.90	1.31 (0.60 - 2.48)
Male Reproductive	43	38.56	1.12 (0.81 - 1.50)	**314**	**259.59**	**1.21 (1.08 - 1.35)**
Prostate	43	35.53	1.21 (0.88 - 1.63)	**282**	**228.41**	**1.23 (1.09 - 1.39)**
Testis	0	0.58	-	**31**	**20.90**	**1.48 (1.01 - 2.11)**
Urinary tract	8	9.89	0.81 (0.35 - 1.59)	51	55.02	0.93 (0.69 - 1.22)
Kidney	3	3.65	0.82 (0.17 - 2.40)	30	30.44	0.99 (0.66 - 1.41)
Bladder	5	5.53	0.90 (0.29 - 2.11)	18	21.61	0.83 (0.49 - 1.32)
Brain & Other CNS	2	2.06	0.97 (0.12 - 3.51)	15	19.83	0.76 (0.42 - 1.25)
Brain	2	1.98	1.01 (0.12 - 3.64)	14	18.98	0.74 (0.40 - 1.24)
Thyroid & Other Endocrine	0	0.69	-	13	11.35	1.15 (0.61 - 1.96)
Thyroid	0	0.62	-	13	10.43	1.25 (0.66 - 2.13)
Unknown Site	9	5.02	1.79 (0.82 - 3.41)	18	22.27	0.81 (0.48 - 1.28)
Lympho-haematopoetic	**6**	**13.85**	**0.43 (0.16 - 0.94)**	103	100.40	1.03 (0.84 - 1.24)
Hodgkin Disease	0	0.38	-	6	6.18	0.97 (0.36 - 2.11)
Non-Hodgkin Lymphoma	3	5.17	0.58 (0.12 - 1.70)	44	42.86	1.03 (0.75 - 1.38)
Follicular-NHL	1	0.98	1.02 (0.03 - 5.69)	15	11.03	1.36 (0.76 - 2.24)
Diffuse-NHL	2	2.55	0.78 (0.09 - 2.83)	20	20.10	1.00 (0.61 - 1.54)
Myeloma	0	1.88	-	15	11.23	1.34 (0.75 - 2.20)
Leukaemia	1	3.99	0.25 (0.01 - 1.39)	27	26.52	1.02 (0.67 - 1.48)
MDS	1	0.82	1.22 (0.03 - 6.80)	3	3.58	0.84 (0.17 - 2.45)
All Other Cancers	1	1.77	0.56 (0.01 - 3.15)	20	16.99	1.18 (0.72 - 1.82)
Male Breast	0	0.27	-	5	1.73	2.89 (0.94 - 6.73)

* Statistically significantly elevated SIR results are in **red**, statistically significantly reduced SIR results are in **blue**

Table 44: Standardised Cancer Incidence Ratios* and 95% confidence intervals for melanoma among male firefighters to 31/12/2010 by analysis group compared to relevant state rates

	State	O	E	SMR (95%CI)
Career full-time	National	**209**	**143.41**	**1.46 (1.27 - 1.67)**
	ACT	6	7.69	0.78 (0.29 - 1.70)
	NSW	**51**	**29.37**	**1.74 (1.29 - 2.28)**
	NT	3	1.46	2.05 (0.42 - 6.00)
	QLD	42	38.62	1.09 (0.78 - 1.47)
	VIC	**74**	**44.74**	**1.65 (1.30 - 2.08)**
	WA	**33**	**21.53**	**1.53 (1.06 - 2.15)**
Part-time paid	National	**89**	**68.89**	**1.29 (1.04 - 1.59)**
	NSW	**61**	**42.57**	**1.43 (1.10 - 1.84)**
	NT	0	0.80	-
	QLD	28	25.51	1.10 (0.73 - 1.59)
Volunteer	National	912	885.56	1.03 (0.96 - 1.10)
	NSW	376	356.57	1.05 (0.95 - 1.17)
	NT	2	1.06	1.88 (0.23 - 6.81)
	QLD	85	114.27	0.74 (0.59 - 0.92)
	VIC	317	294.16	1.08 (0.96 - 1.20)
	WA	132	119.49	1.10 (0.92 - 1.31)

* Statistically significantly elevated SIR results are in **red**

Table 45: Standardised Cancer Incidence Ratios* and 95% confidence intervals for melanoma among female firefighters to 31/12/2010 by analysis group compared to relevant state rates

	State	O	E	SMR (95%CI)
Career full-time	National	1	1.82	0.55 (0.01 - 3.06)
Part-time paid	National	5	2.77	1.81 (0.59 - 4.22)
Volunteer	National	**147**	**118.26**	**1.24 (1.05 - 1.46)**
	NSW	70	54.98	1.27 (0.99 - 1.61)
	NT	2	0.25	7.98 (0.97 - 28.82)
	QLD	23	22.79	1.01 (0.64 - 1.51)
	VIC	30	23.55	1.27 (0.86 - 1.82)
	WA	22	16.68	1.32 (0.83 - 2.00)

* Statistically significantly elevated SIR results are in **red**

Appendix 6 Tables of Internal Comparisons by Employment Duration, Era and Incidents

Table 46: Cut points for tertiles of cumulative incidents per person-year* used in RMR and RIR analyses

		All Incidents	All Fires	Structural Fires	Landscape Fires	Vehicle Fires
Male career full-time N=12,043	Tertile 1	>0 - 383	>0 - 220	>0 - 85	>0 - 40	>0 - 24
	Tertile 2	>383 - 1053	>220 - 576	>85 - 219	>40 - 143	>24 - 73
	Tertile 3	>1053	>576	>219	>143	>73
Male part-time paid N=7,681	Tertile 1	>0 - 46	>0 - 31	>0 - 9	>0 - 11	>0 - 2.2
	Tertile 2	>46 - 210	>31 - 158	>9 - 45	>11- 61	>2.2 -14.7
	Tertile 3	>210	>158	>45	>61	>14.7
Male volunteers N=144,512	No incidents	0	0	0	0	0
	Tertile 1	>0 - 6.6	>0 - 5.7	>0 - 3	>0 - 4.7	>0 - 2.4
	Tertile 2	>6.6 - 34.6	>5.7 - 25.5	>3 - 10.9	>4.7 - 18.4	>2.4 - 8
	Tertile 3	>34.6	>25.5	>10.9	>18.4	>8
Female volunteers N=32,252	No incidents	0	0	0	0	0
	Tertile 1	>0 - 3	>0 - 2.9	>0 - 2	>0 - 2.2	>0 - 1.6
	Tertile 2	>3 - 16	>2.9 - 12	>2 - 6	>2.2 - 8.5	>1.6 - 4.4
	Tertile 3	>16	>12	>6	>8.5	>4.4

* A firefighter will accumulate incidents as they serve. If a career full-time firefighter attended an average of 50 incidents per year, after six years they will have accumulated 300 incidents and be in tertile 1. After 8 years they will have accumulated 400 incidents and they will be in tertile 2 and after 22 years they will be in tertile 3. If a career full-time firefighter attended 300 incidents a year, they will be in tertile 2 after two years and tertile 3 after four years. Any event such as a cancer or death is attributed to the tertile that the firefighter was in based on the cumulative number of incidents attended at the time the cancer/death event occurred. So if a firefighter is diagnosed with prostate cancer in his fifth year of service, the case would be included in tertile 1 in the first scenario and in tertile 3 for the second scenario.

Table 47: Relative Mortality Ratios (RMR)* and 95% confidence intervals for male career full-time firefighters to 30/11/2011 by duration and period of employment
(adjusted for age and calendar period)

Causes of Death	Duration of Employment	O	RMR (95%CI)	Employed pre- or post-1985	O	RMR (95%CI)
All Causes of Death Combined	>3 months - 10 years	81	Ref			
	10 - 20 years	112	1.02 (0.75 - 1.38)	Pre-1985	211	Ref
	20+ years	578	0.96 (0.72 - 1.28)	Post-1985	**569**	**0.57 (0.47 - 0.69)**
	Trend test		P = 0.68			
All Malignancies	>3 months - 10 years	24	Ref			
	10 - 20 years	39	0.97 (0.58 - 1.64)	Pre-1985	72	Ref
	20+ years	263	0.96 (0.60 - 1.52)	Post-1985	257	0.80 (0.59 - 1.08)
	Trend test		P = 0.85			
All Circulatory	>3 months - 10 years	16	Ref			
	10 - 20 years	27	1.01 (0.53 - 1.93)	Pre-1985	67	Ref
	20+ years	164	1.03 (0.56 - 1.90)	Post-1985	**142**	**0.52 (0.36 - 0.73)**
	Trend test		P = 0.90			
IHD	>3 months - 10 years	13	Ref			
	10 - 20 years	19	0.80 (0.38 - 1.68)	Pre-1985	55	Ref
	20+ years	117	0.85 (0.44 - 1.67)	Post-1985	**95**	**0.38 (0.25 - 0.57)**
	Trend test		P = 0.77			
All Injury & Trauma	>3 months - 10 years	30	Ref			
	10 - 20 years	26	1.01 (0.58 - 1.78)	Pre-1985	16	Ref
	20+ years	28	0.63 (0.31 - 1.30)	Post-1985	**72**	**0.24 (0.13 - 0.45)**
	Trend test		P = 0.26			
Suicide	>3 months - 10 years	17	Ref			
	10 - 20 years	14	0.89 (0.41 - 1.92)	Pre-1985	9	Ref
	20+ years	17	0.78 (0.33 - 1.89)	Post-1985	**41**	**0.28 (0.13 - 0.60)**
	Trend test		P = 0.58			

* Statistically reduced RMR results are in **blue**

Table 48: Relative Mortality Ratios* and 95% confidence intervals for male part-time paid firefighters to 30/11/2011 by duration employment
(adjusted for age and calendar period)

Causes of Death	Duration of Employment	O	RMR (95%CI)
All Causes of Death Combined	>3 months - 10 years	103	Ref
	10 - 20 years	54	0.84 (0.58 - 1.20)
	20+ years	125	0.87 (0.60 - 1.26)
	Trend test		0.47
All Malignancies	>3 months - 10 years	35	Ref
	10 - 20 years	24	0.76 (0.44 - 1.32)
	20+ years	64	0.75 (0.44 - 1.27)
	Trend test		0.31
All Circulatory	>3 months - 10 years	13	Ref
	10 - 20 years	8	0.77 (0.31 - 1.95)
	20+ years	39	1.54 (0.67 - 3.54)
	Trend test		0.24
All Injury & Trauma	>3 months - 10 years	47	Ref
	10 - 20 years	14	0.85 (0.45 - 1.60)
	20+ years	**4**	**0.31 (0.11 - 0.89)**
	Trend test		**0.04**

* Statistically significantly reduced RMR results and statistically significant negative trends are in **blue**

Table 49: Relative Mortality Ratios* and 95% confidence intervals for male volunteer firefighters to 30/11/2011 by duration of employment
(adjusted for age and calendar period)

Causes of Death	Duration of Service	O	RMR (95%CI)
All Causes of Death Combined	>3 months - 10 years	1444	Ref
	10 - 20 years	839	0.96 (0.88 - 1.05)
	20+ years	**2267**	**0.92 (0.85 - 0.98)**
	Trend test		**P = 0.02**
All Malignancies	>3 months - 10 years	582	Ref
	10 - 20 years	342	0.91 (0.80 - 1.04)
	20+ years	**949**	**0.85 (0.76 - 0.94)**
	Trend test		**P < 0.01**
All Nervous System	>3 months - 10 years	29	Ref
	10 - 20 years	**30**	**1.70 (1.00 - 2.82)**
	20+ years	60	1.14 (0.71 - 1.83)
	Trend test		P = 0.78
All Circulatory	>3 months - 10 years	291	Ref
	10 - 20 years	223	1.15 (0.96 - 1.37)
	20+ years	706	1.11 (0.97 - 1.29)
	Trend test		P = 0.18
IHD	>3 months - 10 years	162	Ref
	10 - 20 years	132	1.21 (0.96 - 1.53)
	20+ years	410	1.18 (0.97 - 1.42)
	Trend test		P = 0.12
All Respiratory	>3 months - 10 years	54	Ref
	10 - 20 years	29	0.77 (0.49 - 1.20)
	20+ years	128	0.93 (0.67 - 1.30)
	Trend test		P = 0.83
COPD	>3 months - 10 years	28	Ref
	10 - 20 years	18	0.89 (0.49 - 1.62)
	20+ years	65	0.86 (0.55 - 1.37)
	Trend test		P = 0.54
All Digestive	>3 months - 10 years	37	Ref
	10 - 20 years	20	0.86 (0.50 - 1.49)
	20+ years	50	0.77 (0.49 - 1.20)
	Trend test		P = 0.24
All Injury & Trauma	>3 months - 10 years	352	Ref
	10 - 20 years	**126**	**0.79 (0.64 - 0.97)**
	20+ years	**170**	**0.72 (0.58 - 0.88)**
	Trend test		**P < 0.01**
Suicide	>3 months - 10 years	113	Ref
	10 - 20 years	38	0.73 (0.50 - 1.06)
	20+ years	**48**	**0.68 (0.47 - 0.98)**
	Trend test		**P = 0.03**

* Statistically significantly elevated RMR results are in **red**, statistically significantly reduced RMR results and statistically significant negative trends are in **blue**

Table 50: Relative Mortality Ratios* and 95% confidence intervals for female volunteer firefighters to 30/11/2011 by duration of employment
(adjusted for age and calendar period)

Causes of Death	Duration of Service	O	RMR (95%CI)
All Causes of Death Combined	>3 months - 10 years	270	Ref
	10 - 20 years	119	1.01 (0.81 - 1.26)
	20+ years	118	1.07 (0.85 - 1.34)
		Trend test	P = 0.60
All Malignancies	>3 months - 10 years	140	Ref
	10 - 20 years	60	0.95 (0.70 - 1.29)
	20+ years	61	1.10 (0.80 - 1.50)
		Trend test	P = 0.65
All Circulatory	>3 months - 10 years	38	Ref
	10 - 20 years	28	1.57 (0.96 - 2.57)
	20+ years	28	1.41 (0.84 - 2.37)
		Trend test	P = 0.14
IHD	>3 months - 10 years	18	Ref
	10 - 20 years	10	1.53 (0.70 - 3.33)
	20+ years	8	2.13 (0.92 - 4.95)
		Trend test	P = 0.07
All Respiratory	>3 months - 10 years	13	Ref
	10 - 20 years	4	0.81 (0.26 - 2.47)
	20+ years	3	1.03 (0.29 - 3.60)
		Trend test	P = 0.91
All Injury & Trauma	>3 months - 10 years	46	Ref
	10 - 20 years	10	0.77 (0.38 - 1.53)
	20+ years	8	1.23 (0.56 - 2.68)
		Trend test	P = 0.92
Suicide	>3 months - 10 years	12	Ref
	10 - 20 years	2	0.58 (0.13 - 2.64)
	20+ years	0	-
		Trend test	P = 0.17

Table 51: Relative Mortality Ratios* and 95% confidence intervals for male career full-time firefighters to 30/11/2011 by number of incidents and incident types in tertiles (adjusted for age and calendar period)

Causes of Death	Groups	O	All Incidents	O	All Fire incidents	O	Structural Fire Incidents	O	Landscape Fire Incidents	O	Vehicle Fire Incidents
All Causes of Death Combined	Tertile 1	46	Ref	44	Ref	44	Ref	43	Ref	39	Ref
	Tertile 2	54	1.19 (0.80 - 1.77)	45	1.11 (0.73 - 1.69)	45	1.09 (0.72 - 1.65)	**62**	**1.52 (1.03 - 2.25)**	47	1.39 (0.90 - 2.13)
	Tertile 3	52	0.81 (0.54 - 1.22)	63	0.96 (0.65 - 1.43)	63	0.94 (0.63 - 1.40)	47	0.82 (0.54 - 1.25)	66	1.26 (0.84 - 1.88)
	Trend test		P = 0.30		P = 0.81		P = 0.73		P = 0.30		P = 0.30
All Malignancies	Tertile 1	18	Ref	17	Ref	19	Ref	17	Ref	14	Ref
	Tertile 2	22	1.29 (0.69 - 2.41)	19	1.32 (0.68 - 2.56)	17	1.00 (0.52 - 1.94)	28	1.79 (0.98 - 3.29)	21	1.91 (0.97 - 3.78)
	Tertile 3	26	0.90 (0.49 - 1.66)	30	1.02 (0.56 - 1.86)	30	0.92 (0.52 - 1.65)	21	0.81 (0.42 - 1.54)	31	1.47 (0.78 - 2.78)
	Trend test		P = 0.65		P = 0.96		P = 0.78		P = 0.38		P = 0.33
All Circulatory	Tertile 1	6	Ref	5	Ref	4	Ref	5	Ref	6	Ref
	Tertile 2	13	2.21 (0.83 - 5.84)	**13**	**2.97 (1.05 - 8.40)**	**13**	**3.75 (1.21 - 11.6)**	**14**	**3.02 (1.08 - 8.43)**	11	2.21 (0.81 - 6.05)
	Tertile 3	12	1.41 (0.52 - 3.81)	13	1.72 (0.61 - 4.89)	14	2.34 (0.76 - 7.17)	12	1.79 (0.62 - 5.12)	14	1.75 (0.66 - 4.59)
	Trend test		P = 0.62		P = 0.46		P = 0.25		P = 0.42		P = 0.32
IHD	Tertile 1	5	Ref	4	Ref	3	Ref	4	Ref	5	Ref
	Tertile 2	11	2.20 (0.76 - 6.39)	11	3.12 (0.98 - 9.92)	9	3.36 (0.90 - 12.56)	11	2.91 (0.92 - 9.22)	9	2.19 (0.72 - 6.62)
	Tertile 3	8	1.04 (0.34 - 3.19)	9	1.35 (0.41 - 4.42)	12	2.44 (0.68 - 8.70)	9	1.55 (0.47 - 5.07)	10	1.38 (0.47 - 4.06)
	Trend test		P = 0.88		P = 0.88		P = 0.26		P = 0.65		P = 0.68
All Injury & Trauma	Tertile 1	9	Ref	10	Ref	9	Ref	10	Ref	8	Ref
	Tertile 2	11	1.18 (0.49 - 2.86)	9	0.85 (0.35 - 2.11)	11	1.17 (0.48 - 2.85)	12	1.16 (0.50 - 2.69)	10	1.18 (0.47 - 3.01)
	Tertile 3	9	1.08 (0.41 - 2.86)	10	1.12 (0.43 - 2.87)	9	1.07 (0.40 - 2.85)	7	0.73 (0.27 - 1.97)	11	1.52 (0.58 - 3.94)
	Trend test		P = 0.86		P = 0.85		P = 0.88		P = 0.57		P = 0.39
Suicide	Tertile 1	5	Ref	5	Ref	5	Ref	5	Ref	3	Ref
	Tertile 2	7	1.37 (0.43 - 4.33)	5	0.97 (0.28 - 3.36)	5	0.98 (0.28 - 3.40)	8	1.56 (0.51 - 4.78)	7	2.26 (0.58 - 8.76)
	Tertile 3	5	1.05 (0.29 - 3.84)	7	1.61 (0.47 - 5.54)	7	1.57 (0.46 - 5.32)	4	0.81 (0.21 - 3.15)	7	2.59 (0.64 - 10.54)
	Trend test		P = 0.92		P = 0.46		P = 0.47		P = 0.81		P = 0.19

* Statistically significantly elevated RMR results are in **red**

Table 52: Relative Mortality Ratios and 95% confidence intervals for male part-time paid firefighters to 30/11/2011 by number of incidents and incident types in tertiles (adjusted for age and calendar period)

Causes of Death	Groups	O	All Incidents	O	All Fire Incidents	O	Structural Fire Incidents	O	Landscape Fire incidents	O	Vehicle Fire Incidents
All Causes of Death Combined	Tertile 1	11	Ref	10	Ref	11	Ref	13	Ref	17	Ref
	Tertile 2	21	1.28 (0.61 - 2.68)	18	1.25 (0.57 - 2.74)	19	1.27 (0.60 - 2.68)	15	0.88 (0.42 - 1.85)	14	0.74 (0.37 - 1.51)
	Tertile 3	37	1.20 (0.58 - 2.49)	41	1.62 (0.77 - 3.40)	39	1.26 (0.61 - 2.60)	41	1.32 (0.68 - 2.56)	38	1.03 (0.57 - 1.89)
	Trend test		P = 0.73		P = 0.17		P = 0.58		P = 0.30		P = 0.80
All Malignancies	Tertile 1	2	Ref	1	Ref	1	Ref	2	Ref	4	Ref
	Tertile 2	8	2.15 (0.45 - 10.33)	6	3.48 (0.42 - 29.24)	7	4.52 (0.55 - 36.94)	8	2.73 (0.58 - 12.90)	6	1.36 (0.38 - 4.84)
	Tertile 3	17	1.85 (0.40 - 8.54)	20	5.17 (0.66 - 40.24)	19	4.39 (0.56 - 34.26)	17	2.34 (0.52 - 10.46)	17	1.40 (0.46 - 4.28)
	Trend test		P = 0.63		P = 0.08		P = 0.22		P = 0.40		P = 0.58
All Circulatory	Tertile 1	2	Ref	2	Ref	2	Ref	1	Ref	1	Ref
	Tertile 2	2	0.59 (0.08 - 4.36)	2	0.63 (0.09 - 4.60)	2	0.71 (0.10 - 5.07)	3	2.35 (0.24 - 22.72)	3	2.95 (0.31 - 28.48)
	Tertile 3	7	0.96 (0.16 - 5.63)	7	1.08 (0.19 - 6.01)	7	0.99 (0.18 - 5.60)	7	2.48 (0.28 - 21.79)	7	2.93 (0.34 - 25.02)
	Trend test		P = 0.88		P = 0.79		P = 0.92		P = 0.45		P = 0.36
All Injury & Trauma	Tertile 1	6	Ref	5	Ref	6	Ref	7	Ref	8	Ref
	Tertile 2	8	1.27 (0.44 - 3.68)	8	1.51 (0.49 - 4.65)	9	1.36 (0.48 - 3.84)	4	0.54 (0.16 - 1.85)	5	0.59 (0.19 - 1.82)
	Tertile 3	7	1.21 (0.39 - 3.78)	8	1.68 (0.53 - 5.35)	6	0.99 (0.31 - 3.21)	10	1.51 (0.55 - 4.14)	8	1.02 (0.37 - 2.82)
	Trend test		P = 0.74		P = 0.38		P = 1.00		P = 0.39		P = 0.98

Table 53: Relative Mortality Ratios* and 95% confidence intervals for male volunteer firefighters to 30/11/2011 by number of incidents and incident types in tertiles (adjusted for age and calendar period) Trend test across individuals with incidents only

Causes of Death	Groups	O	All Incidents	O	All Fire Incidents	O	Structural Fire Incidents	O	Landscape Fire Incidents	O	Vehicle Fire Incidents
All Causes of Death Combined	Zero incidents	1546	Ref	1693	Ref	3036	Ref	1898	Ref	3418	Ref
	Tertile 1	688	0.65 (0.59 - 0.71)	599	0.62 (0.57 - 0.69)	208	0.54 (0.47 - 0.62)	507	0.62 (0.56 - 0.69)	158	0.59 (0.50 - 0.69)
	Tertile 2	1116	0.82 (0.76 - 0.89)	1049	0.81 (0.75 - 0.88)	456	0.71 (0.64 - 0.78)	966	0.82 (0.76 - 0.88)	324	0.76 (0.67 - 0.85)
	Tertile 3	964	0.80 (0.74 - 0.87)	973	0.80 (0.74 - 0.86)	614	0.98 (0.90 - 1.07)	943	0.79 (0.73 - 0.85)	414	0.92 (0.83 - 1.01)
	Trend test		P < 0.01		P < 0.01		P < 0.01		P < 0.01		P < 0.01
All Malignancies	Zero incidents	600	Ref	661	Ref	1236	Ref	738	Ref	1390	Ref
	Tertile 1	288	0.74 (0.64 - 0.85)	255	0.72 (0.62 - 0.83)	78	0.56 (0.44 - 0.70)	207	0.70 (0.60 - 0.82)	66	0.69 (0.54 - 0.89)
	Tertile 2	469	0.89 (0.79 - 1.00)	426	0.84 (0.74 - 0.95)	198	0.77 (0.66 - 0.90)	415	0.91 (0.80 - 1.02)	143	0.84 (0.71 - 1.00)
	Tertile 3	409	0.89 (0.78 - 1.01)	424	0.90 (0.79 - 1.02)	254	1.01 (0.88 - 1.16)	406	0.87 (0.77 - 0.99)	167	0.93 (0.79 - 1.09)
	Trend test		P = 0.01		P < 0.01		P < 0.01		P = 0.02		P = 0.08
All Nervous System	Zero incidents	48	Ref	53	Ref	82	Ref	56	Ref	90	Ref
	Tertile 1	16	0.50 (0.28 - 0.88)	12	0.41 (0.22 - 0.76)	4	0.40 (0.15 - 1.10)	10	0.42 (0.22 - 0.84)	5	0.73 (0.30 - 1.83)
	Tertile 2	26	0.63 (0.40 - 1.02)	26	0.65 (0.41 - 1.04)	9	0.53 (0.26 - 1.05)	24	0.70 (0.43 - 1.13)	6	0.54 (0.24 - 1.24)
	Tertile 3	19	0.52 (0.30 - 0.88)	18	0.48 (0.28 - 0.82)	14	0.84 (0.48 - 1.50)	19	0.55 (0.32 - 0.92)	8	0.68 (0.33 - 1.41)
	Trend test		P = 0.94		P = 0.75		P = 0.13		P = 0.61		P = 0.86
All Circulatory	Zero incidents	428	Ref	469	Ref	826	Ref	529	Ref	918	Ref
	Tertile 1	171	0.62 (0.52 - 0.74)	141	0.57 (0.48 - 0.69)	42	0.49 (0.36 - 0.66)	118	0.58 (0.47 - 0.71)	31	0.53 (0.37 - 0.76)
	Tertile 2	283	0.75 (0.65 - 0.87)	264	0.73 (0.63 - 0.85)	107	0.64 (0.52 - 0.78)	229	0.70 (0.60 - 0.82)	76	0.70 (0.56 - 0.89)
	Tertile 3	270	0.84 (0.72 - 0.98)	278	0.85 (0.73 - 0.99)	177	1.08 (0.92 - 1.27)	276	0.85 (0.73 - 0.98)	127	1.10 (0.91 - 1.32)
	Trend test		P < 0.01		P < 0.01		P < 0.01		P < 0.01		P < 0.01
IHD	Zero incidents	240	Ref	261	Ref	458	Ref	288	Ref	507	Ref
	Tertile 1	86	0.55 (0.43 - 0.71)	71	0.51 (0.39 - 0.67)	24	0.49 (0.32 - 0.74)	64	0.57 (0.43 - 0.75)	18	0.55 (0.34 - 0.89)
	Tertile 2	151	0.71 (0.58 - 0.87)	144	0.71 (0.58 - 0.87)	63	0.67 (0.51 - 0.87)	125	0.69 (0.56 - 0.86)	49	0.81 (0.60 - 1.08)
	Tertile 3	174	0.95 (0.78 - 1.15)	175	0.94 (0.77 - 1.14)	106	1.15 (0.93 - 1.42)	174	0.96 (0.80 - 1.16)	77	1.19 (0.93 - 1.51)
	Trend test		P < 0.01		P < 0.01		P < 0.01		P < 0.01		P < 0.01
All Respiratory	Zero incidents	78	Ref	88	Ref	154	Ref	107	Ref	169	Ref
	Tertile 1	27	0.58 (0.37 - 0.89)	16	0.37 (0.22 - 0.64)	7	0.51 (0.24 - 1.10)	12	0.32 (0.18 - 0.58)	6	0.66 (0.29 - 1.50)
	Tertile 2	66	1.00 (0.72 - 1.40)	68	1.05 (0.76 - 1.44)	26	0.89 (0.59 - 1.35)	47	0.74 (0.52 - 1.04)	15	0.81 (0.48 - 1.38)
	Tertile 3	31	0.58 (0.38 - 0.88)	30	0.53 (0.35 - 0.80)	15	0.53 (0.31 - 0.90)	36	0.58 (0.40 - 0.85)	12	0.60 (0.33 - 1.08)
	Trend test		P = 0.91		P = 0.64		P = 0.65		P = 0.19		P = 0.69
COPD	Zero incidents	44	Ref	48	Ref	85	Ref	58	Ref	90	Ref
	Tertile 1	11	0.42 (0.22 - 0.82)	6	0.26 (0.11 - 0.61)	3	0.42 (0.13 - 1.33)	3	0.15 (0.05 - 0.48)	4	0.89 (0.32 - 2.43)
	Tertile 2	36	0.98 (0.63 - 1.52)	37	1.05 (0.68 - 1.62)	13	0.81 (0.45 - 1.45)	26	0.76 (0.48 - 1.20)	8	0.82 (0.40 - 1.69)
	Tertile 3	16	0.53 (0.30 - 0.94)	16	0.51 (0.29 - 0.91)	6	0.38 (0.17 - 0.88)	20	0.60 (0.36 - 0.99)	5	0.47 (0.19 - 1.16)
	Trend test		P = 0.71		P = 0.45		P = 0.53		P = 0.09		P = 0.24

Causes of Death	Groups	O	All Incidents	O	All Fire Incidents	O	Structural Fire Incidents	O	Landscape Fire Incidents	O	Vehicle Fire Incidents
All Digestive	Zero incidents	35	Ref	36	Ref	69	Ref	43	Ref	75	Ref
	Tertile 1	20	0.83 (0.48 - 1.44)	20	0.97 (0.56 - 1.67)	6	0.67 (0.29 - 1.56)	14	0.74 (0.40 - 1.36)	5	0.84 (0.34 - 2.10)
	Tertile 2	23	0.75 (0.44 - 1.26)	27	0.98 (0.59 - 1.61)	15	1.00 (0.57 - 1.74)	28	1.03 (0.64 - 1.67)	12	1.23 (0.67 - 2.27)
	Tertile 3	27	0.95 (0.57 - 1.57)	22	0.81 (0.48 - 1.39)	15	1.01 (0.58 - 1.78)	20	0.70 (0.41 - 1.20)	13	1.27 (0.71 - 2.30)
	Trend test		P = 0.60		P = 0.56		P = 0.36		P = 0.76		P = 0.56
All Injury & Trauma	Zero incidents	218	Ref	235	Ref	412	Ref	252	Ref	470	Ref
	Tertile 1	**119**	**0.64 (0.51 - 0.80)**	**114**	**0.65 (0.52 - 0.82)**	**55**	**0.60 (0.45 - 0.80)**	**110**	**0.72 (0.57 - 0.90)**	**36**	**0.52 (0.37 - 0.73)**
	Tertile 2	**148**	**0.78 (0.63 - 0.96)**	**141**	**0.78 (0.63 - 0.96)**	**62**	**0.63 (0.48 - 0.82)**	142	0.88 (0.72 - 1.09)	53	0.76 (0.57 - 1.01)
	Tertile 3	**138**	**0.74 (0.59 - 0.91)**	**133**	**0.75 (0.61 - 0.93)**	94	0.99 (0.79 - 1.24)	**119**	**0.76 (0.61 - 0.94)**	64	0.91 (0.70 - 1.18)
	Trend test		P = 0.27		P = 0.29		**P < 0.01**		P = 0.77		**P < 0.01**
Suicide	Zero incidents	63	Ref	73	Ref	122	Ref	78	Ref	136	Ref
	Tertile 1	42	0.75 (0.51 - 1.11)	**36**	**0.63 (0.42 - 0.95)**	21	0.72 (0.46 - 1.16)	37	0.74 (0.50 - 1.10)	13	0.61 (0.34 - 1.08)
	Tertile 2	38	0.67 (0.45 - 1.01)	39	0.68 (0.46 - 1.00)	**14**	**0.46 (0.26 - 0.80)**	42	0.82 (0.56 - 1.19)	16	0.76 (0.45 - 1.27)
	Tertile 3	50	0.88 (0.60 - 1.27)	45	0.77 (0.53 - 1.13)	36	1.22 (0.84 - 1.77)	36	0.70 (0.47 - 1.04)	28	1.32 (0.88 - 1.99)
	Trend test		P = 0.45		P = 0.36		**P = 0.03**		P = 0.77		**P = 0.01**

* Statistically significantly reduced RMR results are in **blue,** statistically significant positive trends are in **red**

Table 54: Relative Mortality Ratios* and 95% confidence intervals for female volunteer firefighters to 30/11/2011 by number of incidents and incident types in tertiles (adjusted for age and calendar period) Trend test across individuals with incidents only

Causes of Death	Groups	O	All Incidents	O	All Fire Incidents	O	Structural Fire Incidents	O	Landscape Fire Incidents	O	Vehicle Fire Incidents
All Causes of Death Combined	Zero incidents	271	Ref	288	Ref	401	Ref	309	Ref	414	Ref
	Tertile 1	53	0.79 (0.59 - 1.07)	56	0.88 (0.66 - 1.17)	**13**	**0.51 (0.29 - 0.89)**	40	0.76 (0.55 - 1.06)	11	0.62 (0.34 - 1.14)
	Tertile 2	82	1.05 (0.82 - 1.34)	63	0.93 (0.70 - 1.22)	32	0.98 (0.68 - 1.40)	61	0.94 (0.71 - 1.23)	24	1.07 (0.71 - 1.62)
	Tertile 3	71	1.14 (0.88 - 1.49)	70	1.17 (0.90 - 1.53)	31	1.05 (0.73 - 1.52)	67	1.13 (0.87 - 1.48)	28	1.32 (0.90 - 1.94)
	Trend test		**P = 0.05**		P = 0.11		**P = 0.03**		**P = 0.05**		**P = 0.04**
All Malignancies	Zero incidents	124	Ref	132		200	Ref	142	Ref	207	Ref
	Tertile 1	33	1.07 (0.73 - 1.58)	36	1.22 (0.84 - 1.77)	**5**	**0.39 (0.16 - 0.95)**	24	1.00 (0.64 - 1.54)	8	0.93 (0.46 - 1.89)
	Tertile 2	45	1.25 (0.89 - 1.76)	34	1.09 (0.75 - 1.60)	20	1.24 (0.78 - 1.96)	34	1.14 (0.78 - 1.65)	11	0.99 (0.54 - 1.82)
	Tertile 3	40	1.41 (0.98 - 2.02)	**40**	**1.45 (1.02 - 2.08)**	17	1.17 (0.71 - 1.92)	**42**	**1.52 (1.07 - 2.15)**	16	1.52 (0.91 - 2.53)
	Trend test		P = 0.24		P = 0.45		**P = 0.05**		P = 0.08		P = 0.20
All Circulatory	Zero incidents	52	Ref	55		72	Ref	61	Ref	76	Ref
	Tertile 1	7	0.60 (0.27 - 1.32)	8	0.74 (0.35 - 1.55)	3	0.81 (0.25 - 2.59)	5	0.55 (0.22 - 1.37)	1	0.38 (0.05 - 2.78)
	Tertile 2	16	1.16 (0.66 - 2.04)	11	0.91 (0.48 - 1.74)	5	0.94 (0.38 - 2.34)	9	0.75 (0.37 - 1.50)	4	1.10 (0.40 - 3.03)
	Tertile 3	12	1.17 (0.62 - 2.22)	13	1.31 (0.71 - 2.42)	7	1.55 (0.71 - 3.39)	12	1.16 (0.62 - 2.16)	6	1.80 (0.78 - 4.17)
	Trend test		P = 0.20		P = 0.21		P = 0.28		P = 0.14		P = 0.11
IHD	Zero incidents	21	Ref	22		29	Ref	26	Ref	29	Ref
	Tertile 1	3	0.48 (0.14 - 1.60)	4	0.66 (0.23 - 1.91)	0	0	2	0.35 (0.08 - 1.45)	0	-
	Tertile 2	6	0.82 (0.33 - 2.04)	5	0.81 (0.31 - 2.14)	3	1.01 (0.31 - 3.32)	3	0.47 (0.14 - 1.57)	2	0.98 (0.23 - 4.10)
	Tertile 3	2	0.29 (0.07 - 1.26)	1	0.16 (0.02 - 1.20)	0	0	1	0.15 (0.02 - 1.13)	1	0.49 (0.07 - 3.56)
	Trend test		P = 0.59		P = 0.25		P = 0.96		P = 0.54		P = 0.55
All Respiratory	Zero incidents	15	Ref	15	Ref	17	Ref	15	Ref	16	Ref
	Tertile 1	1	0.23 (0.03 - 1.77)	1	0.25 (0.03 - 1.91)	0	0	1	0.31 (0.04 - 2.36)	0	-0
	Tertile 2	0	-	0	-	0	-	0	-	2	1.83 (0.42 - 7.94)
	Tertile 3	2	0.43 (0.10 - 1.86)	2	0.48 (0.11 - 2.12)	1	0.59 (0.08 - 4.47)	2	0.54 (0.12 - 2.35)	0	-
	Trend test		P = 0.52		P = 0.49		P = 1.00		P = 0.56		P = 0.89
All Injury & Trauma	Zero incidents	33	Ref	35	Ref	50	Ref	38	Ref	54	Ref
	Tertile 1	6	0.57 (0.24 - 1.36)	7	0.67 (0.03 - 1.51)	4	0.77 (0.28 - 2.14)	7	0.74 (0.33 - 1.67)	2	0.48 (0.12 - 1.96)
	Tertile 2	13	1.05 (0.55 - 1.99)	12	1.13 (0.59 - 2.18)	4	0.70 (0.25 - 1.95)	12	1.23 (0.64 - 2.35)	3	0.70 (0.22 - 2.25)
	Tertile 3	10	0.84 (0.41 - 1.70)	8	0.74 (0.34 - 1.60)	4	0.70 (0.25 - 1.94)	5	0.50 (0.20 - 1.28)	3	0.69 (0.22 - 2.22)
	Trend test		P = 0.54		P = 0.86		P = 0.88		P = 0.51		P = 0.71

* Statistically significantly increased RMR results and statistically significant positive trends are in **red**, statistically significantly reduced RMR results are in **blue**

Table 55: Relative Incident Ratios (RIR)* and 95% confidence intervals for male career full-time firefighters to 31/12/2010 by duration and period of employment (adjusted for age and calendar period)

Cancer Categories	Duration of Employment	O	RIR (95%CI)	Duration of Employment	O	RIR (95%CI)	Employed pre- or post-1985	O	RIR (95%CI)
All Malignancies	>3 months - 10 years	138	Ref	>1 year - 10 years	119	Ref			
	10 - 20 years	196	1.09 (0.87 - 1.37)	10 - 20 years	196	1.17 (0.92 - 1.48)	Pre-1985	154	Ref
	20+ years	866	1.08 (0.87 - 1.34)	20+ years	866	1.16 (0.92 - 1.46)	Post-1985	1054	1.04 (0.86 - 1.25)
	Trend test		P = 0.58	Trend test		P = 0.31			
Lip, Oral Cavity & Pharynx	>3 months - 10 years	9	Ref	>1 year - 10 years	8	Ref			
	10 - 20 years	12	1.37 (0.58 - 3.29)	10 - 20 years	12	1.43 (0.58 - 3.53)	Pre-1985	7	Ref
	20+ years	34	1.42 (0.60 - 3.38)	20+ years	34	1.44 (0.58 - 3.57)	Post-1985	48	0.63 (0.27 - 1.44)
	Trend test		P = 0.46	Trend test		P = 0.43			
Digestive Organs	>3 months - 10 years	20	Ref	>1 year - 10 years	17	Ref			
	10 - 20 years	27	0.78 (0.43 - 1.41)	10 - 20 years	27	0.83 (0.45 - 1.55)	Pre-1985	40	Ref
	20+ years	183	0.92 (0.56 - 1.53)	20+ years	183	1.00 (0.58 - 1.73)	Post-1985	190	0.88 (0.59 - 1.29)
	Trend test		P = 0.97	Trend test		P = 0.71			
Colorectal	>3 months - 10 years	14	Ref	>1 year - 10 years	13	Ref			
	10 - 20 years	20	0.79 (0.39 - 1.57)	10 - 20 years	20	0.76 (0.37 - 1.54)	Pre-1985	23	Ref
	20+ years	123	0.91 (0.50 - 1.66)	20+ years	123	0.89 (0.48 - 1.65)	Post-1985	134	1.03 (0.63 - 1.69)
	Trend test		P = 0.99	Trend test		P = 0.97			
Respiratory	>3 months - 10 years	9	Ref	>1 year - 10 years	8	Ref			
	10 - 20 years	15	1.28 (0.55 - 2.96)	10 - 20 years	15	1.34 (0.56 - 3.22)	Pre-1985	19	Ref
	20+ years	75	0.99 (0.45 - 2.18)	20+ years	75	1.04 (0.45 - 2.41)	Post-1985	81	0.95 (0.55 - 1.66)
	Trend test		P =0.75	Trend test		P = 0.84			
Lung	>3 months - 10 years	8	Ref	>1 year - 10 years	7	Ref			
	10 - 20 years	11	1.01 (0.40 - 2.56)	10 - 20 years	11	1.08 (0.41 - 2.85)	Pre-1985	18	Ref
	20+ years	66	0.84 (0.36 - 1.96)	20+ years	66	0.91 (0.37 - 2.23)	Post-1985	**68**	**0.88 (0.50 - 0.60)**
	Trend test		P = 0.60	Trend test		P = 0.72			
Melanoma	>3 months - 10 years	35	Ref	>1 year - 10 years	31	Ref			
	10 - 20 years	50	1.26 (0.80 - 2.00)	10 - 20 years	50	1.34 (0.83 - 2.17)	Pre-1985	17	Ref
	20+ years	122	1.11 (0.68 - 1.81)	20+ years	122	1.16 (0.70 - 1.94)	Post-1985	192	1.33 (0.77 - 2.29)
	Trend test		P = 0.79	Trend test		P = 0.72			

Cancer Categories	Duration of Employment	O	RIR (95%CI)	Duration of Employment	O	RIR (95%CI)	Employed pre- or post-1985	O	RIR (95%CI)
Male Reproductive	>3 months - 10 years	40	Ref	>1 year - 10 years	35	Ref			
	10 - 20 years	37	0.82 (0.53 - 1.30)	10 - 20 years	37	0.87 (0.55 - 1.39)	Pre-1985	43	Ref
	20+ years	277	1.23 (0.83 - 1.81)	20+ years	277	1.32 (0.87 - 1.99)	Post-1985	314	1.00 (0.71 - 1.42)
	Trend test		P = 0.14	Trend test		P = 0.07			
Prostate	>3 months - 10 years	23	Ref	>1 year - 10 years	19	Ref			
	10 - 20 years	30	1.05 (0.61 - 1.82)	10 - 20 years	30	1.17 (0.65 - 2.09)	Pre-1985	43	Ref
	20+ years	270	1.56 (0.98 - 2.51)	20+ years	270	**1.77 (1.06 - 2.97)**	Post-1985	283	1.00 (0.68 - 1.36)
	Trend test		**P = 0.02**	Trend test		**P = 0.01**			
Testis	>3 months - 10 years	17	Ref	>1 year - 10 years	16	Ref			
	10 - 20 years	7	0.60 (0.24 - 1.52)	10 - 20 years	7	0.60 (0.23 - 1.54)	Pre-1985	0	Ref
	20+ years	7	0.67 (0.20 - 2.31)	20+ years	7	0.65 (0.19 - 2.24)	Post-1985	31	-
	Trend test		P = 0.39	Trend test		P = 0.37			
Urinary tract	>3 months - 10 years	2	Ref	>1 year - 10 years	2	Ref			
	10 - 20 years	**12**	**5.63 (1.25 - 25.30)**	10 - 20 years	12	**5.20 (1.16 - 23.43)**	Pre-1985	8	Ref
	20+ years	**45**	**5.92 (1.33 - 23.30)**	20+ years	45	**5.46 (1.22 - 24.37)**	Post-1985	51	0.64 (0.30 - 1.39)
	Trend test		**P = 0.03**	Trend test		**P = 0.04**			
Kidney	>3 months - 10 years	1	Ref	>1 year - 10 years	1	Ref			
	10 - 20 years	7	6.95 (0.85 - 56.81)	10 - 20 years	7	6.47 (0.79 - 52.97)	Pre-1985	3	Ref
	20+ years	**25**	**8.19 (1.01 - 66.62)**	20+ years	25	7.61 (0.93 - 62.23)	Post-1985	30	0.63 (0.19 - 2.12)
	Trend test		**P = 0.05**	Trend test		P = 0.06			
Lympho-haematopoetic	>3 months - 10 years	10	Ref	>1 year - 10 years	8	Ref			
	10 - 20 years	**22**	**2.38 (1.08 - 5.26)**	10 - 20 years	22	**2.82 (1.20 - 6.64)**	Pre-1985	6	Ref
	20+ years	**75**	**3.08 (2.32 - 7.20)**	20+ years	75	**3.66 (1.45 - 9.24)**	Post-1985	103	2.32 (0.96 - 5.56)
	Trend test		**P = 0.01**	Trend test		**P = 0.01**			
NHL	>3 months - 10 years	5	Ref	>1 year - 10 years	3	Ref			
	10 - 20 years	9	2.12 (0.71 - 6.34)	10 - 20 years	9	3.28 (0.88 - 12.15)	Pre-1985	3	Ref
	20+ years	31	**3.67 (1.28 - 10.54)**	20+ years	31	**5.53 (1.53 - 19.94)**	Post-1985	44	1.11 (0.33 - 3.68)
	Trend test		**P = 0.01**	Trend test		**P = 0.01**			

* Statistically significantly increased RIR results and statistically significant positive trends are in **red,** statistically significantly reduced RIR results are in **blue**

Table 56: Relative Incident Ratios* and 95% confidence intervals for male part-time paid firefighters to 31/12/2010 by duration of employment
(adjusted for age and calendar period)

Cancer Categories	Duration of Employment	O	RIR (95%CI)
All Malignancies	>3 months - 10 years	144	Ref
	10 - 20 years	114	1.07 (0.82 - 1.40)
	20+ years	223	0.98 (0.74 - 1.29)
	Trend test		P = 0.84
Lip, Oral Cavity & Pharynx	>3 months - 10 years	11	Ref
	10 - 20 years	6	1.50 (0.52 - 4.37)
	20+ years	4	1.24 (0.35 - 4.42)
	Trend test		P = 0.65
Digestive Organs	>3 months - 10 years	25	Ref
	10 - 20 years	17	1.14 (0.61 - 2.15)
	20+ years	**43**	**3.02 (1.79 - 5.01)**
	Trend test		**P < 0.01**
Colorectal	>3 months - 10 years	16	Ref
	10 - 20 years	11	1.20 (0.54 - 2.65)
	20+ years	**30**	**3.46 (1.80 - 6.65)**
	Trend test		**P < 0.01**
Melanoma	>3 months - 10 years	36	Ref
	10 - 20 years	15	0.88 (0.46 - 1.69)
	20+ years	36	1.64 (0.83 - 3.23)
	Trend test		P = 0.19
Male Reproductive	>3 months - 10 years	32	Ref
	10 - 20 years	47	1.52 (0.94 - 2.46)
	20+ years	86	1.10 (0.68 - 1.80)
	Trend test		P = 0.99
Prostate	>3 months - 10 years	26	Ref
	10 - 20 years	**41**	**1.77 (1.06 - 2.95)**
	20+ years	**86**	**2.15 (1.33 - 3.46)**
	Trend test		**P < 0.01**
Lympho-haematopoetic	>3 months - 10 years	18	Ref
	10 - 20 years	7	0.71 (0.29 - 1.76)
	20+ years	18	1.96 (0.96 - 4.02)
	Trend test		P = 0.07

* Statistically significantly increased RIR results and statistically significant positive trends are in **red**

Table 57: Relative Incident Ratios* and 95% confidence intervals for male volunteer firefighters to 31/12/2010 by duration of employment (adjusted for age and calendar period)

Cancer Categories	Duration of Employment	O	RIR (95%CI)
All Malignancies	>3 months - 10 years	2206	Ref
	10 - 20 years	1315	1.00 (0.93 - 1.07)
	20+ years	3452	0.99 (0.93 - 1.04)
	Trend test		P = 0.67
Lip, Oral Cavity & Pharynx	>3 months - 10 years	82	Ref
	10 - 20 years	48	1.05 (0.73 - 1.50)
	20+ years	111	1.08 (0.79 - 1.46)
	Trend test		P = 0.64
Digestive Organs	>3 months - 10 years	397	Ref
	10 - 20 years	220	0.89 (0.75 - 1.05)
	20+ years	662	0.97 (0.85 - 1.10)
	Trend test		P = 0.73
Colorectal	>3 months - 10 years	268	Ref
	10 - 20 years	147	0.87 (0.71 - 1.07)
	20+ years	469	1.01 (0.86 - 1.18)
	Trend test		P = 0.80
Respiratory	>3 months - 10 years	136	Ref
	10 - 20 years	101	1.18 (0.91 - 1.53)
	20+ years	187	0.76 (0.61 - 0.96)
	Trend test		**P < 0.01**
Lung	>3 months - 10 years	114	Ref
	10 - 20 years	86	1.19 (0.90 - 1.57)
	20+ years	168	0.79 (0.62 - 1.01)
	Trend test		**P = 0.03**
Melanoma	>3 months - 10 years	336	Ref
	10 - 20 years	194	1.04 (0.87 - 1.24)
	20+ years	370	0.92 (0.78 - 1.08)
	Trend test		P = 0.29
Male Reproductive	>3 months - 10 years	752	Ref
	10 - 20 years	497	1.07 (0.96 - 1.20)
	20+ years	**1480**	**1.13 (1.04 - 1.24)**
	Trend test		**P = 0.01**
Prostate	>3 months - 10 years	701	Ref
	10 - 20 years	470	1.06 (0.95 - 1.19)
	20+ years	**1452**	**1.12 (1.02 - 1.23)**
	Trend test		**P = 0.02**
Testis	>3 months - 10 years	48	Ref
	10 - 20 years	25	1.36 (0.83 - 2.21)
	20+ years	**25**	**1.76 (1.00 - 3.08)**
	Trend test		**P = 0.04**
Urinary tract	>3 months - 10 years	105	Ref
	10 - 20 years	56	0.86 (0.62 - 1.19)
	20+ years	169	0.94 (0.73 - 1.22)
	Trend test		P = 0.72
Kidney	>3 months - 10 years	65	Ref
	10 - 20 years	32	0.81 (0.53 - 1.24)
	20+ years	98	1.00 (0.72 - 1.40)
	Trend test		P = 0.92
Lympho-haematopoetic	>3 months - 10 years	239	Ref
	10 - 20 years	126	0.91 (0.73 - 1.12)
	20+ years	296	0.84 (0.70 - 1.01)
	Trend test		P = 0.06
NHL	>3 months - 10 years	100	Ref
	10 - 20 years	48	0.82 (0.58 - 1.20)
	20+ years	118	0.82 (0.62 - 1.08)
	Trend test		P = 0.16

* Statistically significantly elevated RIR results and statistically significant positive trends are in **red**, statistically significantly negative trends are in **blue**

Table 58: Relative Incident Ratios* and 95% confidence intervals for female volunteer firefighters to 31/12/2010 by duration of employment (adjusted for age and calendar period)

Cancer Categories	Duration of Employment	O	RIR (95%CI)
All Malignancies	>3 months - 10 years	614	Ref
	10 - 20 years	220	0.91 (0.78 - 1.07)
	20+ years	162	0.96 (0.80 - 1.15)
	Trend test		P = 0.47
Lip, Oral Cavity & Pharynx	>3 months - 10 years	8	Ref
	10 - 20 years	4	1.52 (0.45 - 5.16)
	20+ years	4	2.53 (0.72 - 9.00)
	Trend test		P = 0.20
Digestive Organs	>3 months - 10 years	97	Ref
	10 - 20 years	31	0.69 (0.46 - 1.04)
	20+ years	27	0.69 (0.45 - 1.07)
	Trend test		**P = 0.05**
Colorectal	>3 months - 10 years	78	Ref
	10 - 20 years	27	0.75 (0.49 - 1.17)
	20+ years	20	0.65 (0.39 - 1.07)
	Trend test		P = 0.06
Respiratory	>3 months - 10 years	42	Ref
	10 - 20 years	12	0.69 (0.36 - 1.32)
	20+ years	10	0.82 (0.41 - 1.64)
	Trend test		P = 0.38
Lung	>3 months - 10 years	42	Ref
	10 - 20 years	11	0.64 (0.33 - 1.24)
	20+ years	10	0.82 (0.41 - 1.64)
	Trend test		P = 0.35
Melanoma	>3 months - 10 years	98	Ref
	10 - 20 years	28	0.81 (0.53 - 1.24)
	20+ years	16	0.76 (0.44 - 1.31)
	Trend test		P = 0.23
Female Reproductive	>3 months - 10 years	44	Ref
	10 - 20 years	**29**	**1.62 (1.01 - 2.61)**
	20+ years	13	1.00 (0.53 - 1.90)
	Trend test		P = 0.52
Urinary tract	>3 months - 10 years	15	Ref
	10 - 20 years	2	0.34 (0.08 - 1.47)
	20+ years	5	1.21 (0.43 - 3.39)
	Trend test		P = 0.90
Kidney	>3 months - 10 years	12	Ref
	10 - 20 years	2	0.43 (0.10 - 1.93)
	20+ years	4	1.25 (0.39 - 4.00)
	Trend test		P = 1.00
Lympho-haematopoetic	>3 months - 10 years	54	Ref
	10 - 20 years	21	1.06 (0.63 - 1.77)
	20+ years	13	0.91 (0.48 - 1.73)
	Trend test		P = 0.87
NHL	>3 months - 10 years	25	Ref
	10 - 20 years	9	1.05 (0.48 - 2.27)
	20+ years	4	0.75 (0.25 - 2.21)
	Trend test		P = 0.69

* Statistically significantly elevated RIR results are in **red**, statistically significant negative trends are in **blue**

Table 59: Relative Incident Ratios* and 95% confidence intervals for male career full-time firefighters to 31/12/2010 by number of incidents and incident types in tertiles (adjusted for age and calendar period)

Cancer Categories	Groups	O	All Incidents	O	All Fire Incidents	O	Structural Fire Incidents	O	Landscape Fire Incidents	O	Vehicle Fire Incidents
All Malignancies	Tertile 1	102	Ref	101	Ref	110	Ref	96	Ref	98	Ref
	Tertile 2	126	1.29 (0.99 - 1.68)	110	1.23 (0.94 - 1.62)	116	1.16 (0.89 - 1.51)	**142**	**1.54 (1.18 - 1.99)**	**122**	**1.48 (1.13 - 1.93)**
	Tertile 3	180	1.13 (0.88 - 1.45)	197	1.21 (0.95 - 1.55)	182	1.06 (0.83 - 1.35)	170	1.18 (0.92 - 1.53)	**188**	**1.34 (1.04 - 1.71)**
		Trend test	P = 0.44		P = 0.15		P = 0.70		P = 0.35		**P = 0.04**
Lip, Oral Cavity & Pharynx	Tertile 1	6	Ref	6	Ref	5	Ref	5	Ref	5	Ref
	Tertile 2	3	0.52 (0.13 - 2.10)	2	0.36 (0.07 - 1.78)	2	0.43 (0.08 - 2.19)	3	0.60 (0.15 - 2.55)	5	1.11 (0.32 - 3.85)
	Tertile 3	6	0.76 (0.24 - 2.40)	7	0.92 (0.30 - 2.81)	8	1.36 (0.43 - 4.27)	7	1.10 (0.34 - 3.51)	5	0.81 (0.23 - 2.84)
		Trend test	P = 0.65		P = 0.90		P = 0.54		P = 0.84		P = 0.74
Digestive Organs	Tertile 1	20	Ref	15	Ref	17	Ref	14	Ref	15	Ref
	Tertile 2	18	0.95 (0.50 - 1.81)	18	1.44 (0.72 - 2.87)	18	1.23 (0.63 - 2.40)	24	1.87 (0.96 - 3.62)	18	1.54 (0.77 - 3.09)
	Tertile 3	28	0.87 (0.49 - 1.55)	33	1.28 (0.69 - 2.38)	31	1.07 (0.59 - 1.95)	28	1.32 (0.69 - 2.52)	33	1.48 (0.80 - 2.73)
		Trend test	P = 0.63		P = 0.50		P = 0.88		P = 0.55		P = 0.25
Colorectal	Tertile 1	16	Ref	12	Ref	15	Ref	10	Ref	13	Ref
	Tertile 2	15	0.98 (0.48 - 1.99)	13	1.28 (0.58 - 2.83)	13	0.97 (0.46 - 2.05)	**21**	**2.26 (1.06 - 4.82)**	13	1.28 (0.59 - 2.77)
	Tertile 3	23	0.84 (0.44 - 1.59)	29	1.30 (0.66 - 2.56)	26	0.95 (0.50 - 1.80)	23	1.42 (0.67 - 2.99)	28	1.34 (0.69 - 2.60)
		Trend test	P = 0.56		P = 0.47		P = 0.88		P = 0.56		P = 0.40
Respiratory	Tertile 1	6	Ref	6	Ref	6	Ref	8	Ref	5	Ref
	Tertile 2	4	0.72 (0.20 - 2.55)	5	0.97 (0.30 - 3.21)	6	1.19 (0.38 - 3.70)	6	0.83 (0.29 - 2.40)	5	1.21 (0.35 - 4.23)
	Tertile 3	12	1.58 (0.59 - 4.28)	11	1.37 (0.50 - 3.76)	10	1.23 (0.44 - 3.42)	8	0.79 (0.29 - 2.13)	12	1.97 (0.69 - 5.64)
		Trend test	P = 0.31		P = 0.52		P = 0.70		P = 0.64		P = 0.19
Lung	Tertile 1	5	Ref	5	Ref	5	Ref	7	Ref	4	Ref
	Tertile 2	4	0.88 (0.24 - 3.31)	4	0.98 (0.26 - 3.70)	5	1.23 (0.35 - 4.28)	4	0.65 (0.19 - 2.24)	4	0.28 (0.32 - 5.16)
	Tertile 3	7	1.07 (0.34 - 3.43)	7	0.99 (0.31 - 3.18)	6	0.84 (0.25 - 2.76)	5	0.55 (0.17 - 1.76)	8	1.59 (0.47 - 5.30)
		Trend test	P = 0.90		P = 0.99		P = 0.75		P = 0.31		P = 0.45
Melanoma	Tertile 1	26	Ref	24	Ref	30	Ref	24	Ref	26	Ref
	Tertile 2	36	1.37 (0.82 - 2.27)	36	1.55 (0.92 - 2.60)	29	0.98 (0.59 - 1.64)	40	1.62 (0.97 - 2.70)	38	1.56 (0.94 - 2.58)
	Tertile 3	31	0.82 (0.48 - 1.40)	33	0.92 (0.54 - 1.59)	34	0.80 (0.48 - 1.33)	29	0.86 (0.50 - 1.50)	29	0.81 (0.47 - 1.39)
		Trend test	P = 0.40		P = 0.68		P = 0.38		P = 0.50		P = 0.39

Cancer Categories	Groups	O	All Incidents	O	All Fire Incidents	O	Structural Fire Incidents	O	Landscape Fire Incidents	O	Vehicle Fire Incidents
Male Reproductive	Tertile 1	20	Ref	23	Ref	23	Ref	25	Ref	22	Ref
	Tertile 2	**37**	**2.14 (1.24 - 3.70)**	26	1.42 (0.81 - 2.49)	27	1.41 (0.81 - 2.47)	36	1.64 (0.99 - 2.74)	**30**	**1.80 (1.03 - 3.13)**
	Tertile 3	**58**	**1.96 (1.17 - 3.27)**	**66**	**1.91 (1.18 - 3.09)**	**65**	**1.96 (1.21 - 3.17)**	54	1.49 (0.92 - 2.40)	**63**	**2.13 (1.31 - 3.48)**
	Trend test		**P = 0.02**		**P = 0.01**		**P = 0.01**		P = 0.14		**P < 0.01**
Prostate	Tertile 1	14	Ref	15	Ref	16	Ref	18	Ref	16	Ref
	Tertile 2	**29**	**2.49 (1.32 - 4.72)**	20	1.78 (0.91 - 3.48)	20	1.57 (0.81 - 3.04)	27	1.78 (0.98 - 3.24)	**22**	**1.95 (1.02 - 3.73)**
	Tertile 3	**54**	**2.45 (1.35 - 4.41)**	**62**	**2.55 (1.45 - 4.50)**	**61**	**2.45 (1.40 - 4.26)**	**52**	**1.88 (1.09 - 3.22)**	**59**	**2.60 (1.50 - 4.54)**
	Trend test		**P = 0.01**		**P < 0.01**		**P < 0.01**		**P = 0.03**		**P < 0.01**
Testis	Tertile 1	6	Ref	8	Ref	7	Ref	7	Ref	6	Ref
	Tertile 2	8	1.27 (0.44 - 3.66)	6	0.71 (0.25 - 2.04)	7	0.97 (0.34 - 2.78)	9	1.21 (0.45 - 3.26)	8	1.26 (0.44 - 3.65)
	Tertile 3	4	0.62 (0.17 - 2.25)	4	0.46 (0.13 - 1.60)	4	0.54 (0.15 - 1.89)	2	0.26 (0.05 - 1.28)	4	0.62 (0.17 - 2.26)
	Trend test		P = 0.51		P = 0.21		P = 0.35		P = 0.13		P = 0.51
Urinary tract	Tertile 1	5	Ref	4	Ref	5	Ref	3	Ref	4	Ref
	Tertile 2	7	1.57 (0.50 - 4.95)	6	1.80 (0.51 - 6.39)	7	1.58 (0.50 - 4.99)	6	2.18 (0.54 - 8.72)	4	1.23 (0.31 - 4.96)
	Tertile 3	8	0.99 (0.32 - 3.06)	10	1.51 (0.47 - 4.86)	8	1.00 (0.32 - 3.09)	11	2.37 (0.66 - 8.57)	12	2.01 (0.66 - 6.46)
	Trend test		P = 0.91		P = 0.55		P = 0.92		P = 0.21		P = 0.19
Kidney	Tertile 1	2	Ref	2	Ref	3	Ref	2	Ref	2	Ref
	Tertile 2	5	2.73 (0.53 - 14.11)	4	2.30 (0.42 - 12.61)	6	2.23 (0.56 - 8.94)	3	1.60 (0.27 - 9.60)	2	1.17 (0.16 - 8.34)
	Tertile 3	5	1.68 (0.32 - 8.75)	6	1.96 (0.39 - 9.87)	3	0.65 (0.13 - 3.26)	7	2.47 (0.51 - 12.03)	8	2.97 (0.62 - 14.15)
	Trend test		P = 0.65		P = 0.47		P = 0.55		P = 0.24		P = 0.13
Lympho-haematopoetic	Tertile 1	12	Ref	14	Ref	15	Ref	12	Ref	13	Ref
	Tertile 2	11	0.95 (0.42 - 2.16)	12	0.92 (0.42 - 2.01)	17	1.19 (0.59 - 2.40)	15	1.22 (0.57 - 2.63)	16	1.40 (0.65 - 2.86)
	Tertile 3	19	1.06 (0.50 - 2.24)	16	0.76 (0.36 - 1.60)	10	0.46 (0.20 - 1.05)	15	0.86 (0.40 - 1.87)	13	0.72 (0.33 - 1.60)
	Trend test		P = 0.90		P = 0.46		P = 0.07		P = 0.66		P = 0.40
NHL	Tertile 1	6	Ref	7	Ref	8	Ref	6	Ref	5	Ref
	Tertile 2	5	0.88 (0.27 - 2.89)	5	0.78 (0.25 - 2.45)	7	0.95 (0.34 - 2.61)	7	1.17 (0.40 - 3.48)	8	1.76 (0.57 - 5.40)
	Tertile 3	7	0.91 (0.30 - 2.73)	6	0.70 (0.23 - 2.12)	3	0.32 (0.08 - 1.23)	5	0.65 (0.20 - 2.16)	5	0.85 (0.24 - 2.98)
	Trend test		P = 0.86		P = 0.52		**P = 0.11**		P = 0.49		P = 0.81

* Statistically significantly elevated RIR results and statistically significant positive trends are in **red**, statistically significant negative trends are in **blue**

Table 60: Relative Incident Ratios* and 95% confidence intervals for male part-time paid firefighters to 31/12/2010 by number of incidents and incident types in tertiles (adjusted for age and calendar period)

Cancer Categories	Groups	O	All Incidents	O	All Fire Incidents	O	Structural Fire Incidents	O	Landscape Fire Incidents	O	Vehicle Fire Incidents
All Malignancies	Tertile 1	39	Ref	39	Ref	40	Ref	38	Ref	50	Ref
	Tertile 2	47	0.82 (0.53 - 1.26)	46	0.80 (0.52 - 1.24)	39	0.72 (0.46 - 1.12)	46	0.88 (0.57 - 1.36)	40	0.71 (0.47 - 1.08)
	Tertile 3	**75**	**0.64 (0.42 - 0.98)**	76	0.69 (0.46 - 1.04)	82	0.70 (0.46 - 1.05)	77	0.79 (0.52 - 1.18)	**71**	**0.62 (0.42 - 0.90)**
	Trend test		**P = 0.04**		P = 0.08		P = 0.11		P = 0.24		**P = 0.01**
Lip, Oral Cavity & Pharynx	Tertile 1	3	Ref	3	Ref	3	Ref	3	Ref	3	Ref
	Tertile 2	2	0.71 (0.12 - 4.30)	2	0.70 (0.12 - 4.26)	1	0.35 (0.04 - 3.37)	0	-	0	-
	Tertile 3	1	0.40 (0.04 - 4.15)	1	0.39 (0.04 - 4.07)	2	0.84 (0.13 - 5.55)	3	1.29 (0.24 - 6.93)	3	1.29 (0.24 - 6.83)
	Trend test		P = 0.43		P = 0.42		P = 0.77		0.83		P = 0.83
Digestive Organs	Tertile 1	7	Ref	5	Ref	6	Ref	4	Ref	7	Ref
	Tertile 2	4	0.42 (0.12 - 1.44)	5	0.73 (0.21 - 2.53)	4	0.50 (0.14 - 1.77)	7	1.26 (0.37 - 4.32)	4	0.47 (0.14 - 1.60)
	Tertile 3	16	1.17 (0.47 - 2.89)	17	1.78 (0.65 - 4.89)	17	1.44 (0.56 - 3.71)	16	2.11 (0.69 - 6.38)	16	1.33 (0.54 - 3.26)
	Trend test		P = 0.48		P = 0.14		P = 0.25		P = 0.13		P = 0.35
Colorectal	Tertile 1	4	Ref	3	Ref	4	Ref	2	Ref	4	Ref
	Tertile 2	3	0.57 (0.13 - 2.58)	3	0.76 (0.15 - 3.77)	3	0.58 (0.13 - 2.60)	5	1.87 (0.36 - 9.66)	3	0.63 (0.14 - 2.81)
	Tertile 3	12	1.65 (0.52 - 5.25)	13	2.44 (0.68 - 8.78)	12	1.62 (0.51 - 5.17)	12	3.38 (0.74 - 15.41)	12	1.84 (0.58 - 5.80)
	Trend test		P = 0.24		P = 0.08		P = 0.26		P = 0.08		P = 0.18
Melanoma	Tertile 1	9	Ref	9	Ref	10	Ref	10	Ref	9	Ref
	Tertile 2	7	0.64 (0.23 - 1.73)	9	0.80 (0.31 - 2.03)	7	0.58 (0.22 - 1.53)	7	0.58 (0.22 - 1.53)	9	0.93 (0.37 - 2.34)
	Tertile 3	14	0.90 (0.35 - 2.26)	12	0.75 (0.29 - 1.92)	13	0.71 (0.28 - 1.77)	13	0.76 (0.31 - 1.85)	12	0.85 (0.34 - 2.11)
	Trend test		P = 0.89		P = 0.55		P = 0.49		P = 0.59		P = 0.72
Male Reproductive	Tertile 1	10	Ref	14	Ref	12	Ref	13	Ref	19	Ref
	Tertile 2	25	1.51 (0.72 - 3.18)	21	0.90 (0.46 - 1.79)	20	1.12 (0.55 - 2.31)	22	1.11 (0.56 - 2.21)	21	0.95 (0.51 - 1.78)
	Tertile 3	33	0.83 (0.40 - 1.73)	33	0.61 (0.32 - 1.18)	36	0.75 (0.38 - 1.48)	33	0.75 (0.39 - 1.45)	**28**	**0.50 (0.28 - 0.91)**
	Trend test		P = 0.24		P = 0.10		P = 0.26		P = 0.26		**P = 0.01**
Prostate	Tertile 1	7	Ref	11	Ref	9	Ref	10	Ref	16	Ref
	Tertile 2	24	2.30 (0.99 - 5.36)	20	1.21 (0.58 - 2.54)	19	1.54 (0.70 - 3.42)	21	1.41 (0.66 – 3.00)	20	1.08 (0.56 - 2.09)
	Tertile 3	31	1.37 (0.60 - 3.14)	31	0.90 (0.44 - 1.80)	34	1.17 (0.56 - 2.48)	31	1.05 (0.51 - 2.16)	26	0.66 (0.35 - 1.23)
	Trend test		P = 0.97		P = 0.55		P = 0.95		P = 0.83		P = 0.13
Lympho-haematopoetic	Tertile 1	5	Ref	3	Ref	4	Ref	4	Ref	8	Ref
	Tertile 2	5	0.76 (0.22 - 2.65)	6	1.52 (0.38 - 6.11)	4	0.78 (0.19 - 3.12)	5	0.93 (0.25 - 3.49)	**1**	**0.10 (0.01 - 0.83)**
	Tertile 3	4	0.44 (0.11 - 1.66)	5	0.94 (0.22 - 4.04)	6	0.82 (0.23 - 3.01)	5	0.70 (0.18 - 2.68)	5	0.38 (0.12 - 1.18)
	Trend test		P = 0.22		P = 0.83		P = 0.80		P = 0.59		P = 0.09

* Statistically significantly elevated RIR results are in **red**, statistically significantly reduced RIR results and statistically significant negative trends are in **blue**

Table 61: Relative Incident Ratios* and 95% confidence intervals for male volunteer firefighters to 31/12/2010 by number of incidents and incident types in tertiles (adjusted for age and calendar period) Trend test across individuals with incidents only

Cancer Categories	Groups	O	All Incidents	O	All Fire Incidents	O	Structural Fire Incidents	O	Landscape Fire Incidents	O	Vehicle Fire Incidents
All Malignancies	Zero incidents	1768	Ref	1934	Ref	3927	Ref	2186	Ref	4561	Ref
	Tertile 1	**1162**	**0.89 (0.82 - 0.96)**	**1066**	**0.90 (0.83 - 0.97)**	**478**	**0.87 (0.79 - 0.96)**	**933**	**0.91 (0.84 - 0.98)**	359	0.93 (0.83 - 1.04)
	Tertile 2	1706	1.01 (0.94 - 1.08)	1619	1.01 (0.95 - 1.08)	863	0.95 (0.88 - 1.02)	1503	1.03 (0.96 - 1.10)	603	0.96 (0.88 - 1.05)
	Tertile 3	1566	0.98 (0.92 - 1.05)	1583	0.99 (0.92 - 1.06)	934	1.01 (0.94 - 1.09)	1580	1.01 (0.94 - 1.08)	679	1.02 (0.94 - 1.10)
	Trend test		**P = 0.01**		**P = 0.02**		**P = 0.01**		**P = 0.02**		P = 0.14
Lip, Oral Cavity & Pharynx	Zero incidents	53	Ref	56	Ref	131	Ref	65	Ref	152	Ref
	Tertile 1	45	1.08 (0.72 - 1.61)	43	1.16 (0.77 - 1.72)	15	0.68 (0.39 - 1.16)	37	1.09 (0.73 - 1.64)	15	0.95 (0.56 - 1.62)
	Tertile 2	59	1.16 (0.80 - 1.68)	60	1.29 (0.89 - 1.86)	34	1.07 (0.74 - 1.57)	59	1.34 (0.94 - 1.91)	21	0.95 (0.60 - 1.51)
	Tertile 3	54	1.10 (0.75 - 1.62)	52	1.10 (0.76 - 1.61)	31	0.97 (0.66 - 1.44)	50	1.07 (0.74 - 1.55)	23	1.00 (0.64 - 1.55)
	Trend test		P = 0.92		P = 0.76		P = 0.29		P = 0.81		P = 0.90
Digestive Organs	Zero incidents	348	Ref	383	Ref	733	Ref	428	Ref	846	Ref
	Tertile 1	**198**	**0.78 (0.65 - 0.93)**	**183**	**0.79 (0.66 - 0.94)**	**61**	**0.62 (0.48 - 0.81)**	**161**	**0.83 (0.69 - 0.99)**	**46**	**0.68 (0.50 - 0.92)**
	Tertile 2	290	0.85 (0.73 - 1.00)	**265**	**0.82 (0.70 - 0.97)**	152	0.90 (0.75 - 1.07)	256	0.88 (0.76 - 1.03)	119	1.03 (0.85 - 1.25)
	Tertile 3	311	0.99 (0.85 - 1.16)	316	0.99 (0.85 - 1.15)	**201**	**1.17 (1.00 - 1.37)**	302	0.98 (0.84 - 1.13)	136	1.10 (0.92 - 1.32)
	Trend test		**P = 0.01**		**P = 0.01**		**P < 0.01**		P = 0.07		**P = 0.01**
Colorectal	Zero incidents	235	Ref	258	Ref	490	Ref	291	Ref	571	Ref
	Tertile 1	**135**	**0.78 (0.63 - 0.97)**	127	0.82 (0.66 - 1.01)	**46**	**0.71 (0.52 - 0.96)**	110	0.83 (0.67 - 1.03)	37	0.81 (0.58 - 1.14)
	Tertile 2	200	0.87 (0.72 - 1.06)	182	0.84 (0.69 - 1.02)	110	0.97 (0.79 - 1.20)	177	0.90 (0.75 - 1.09)	78	1.01 (0.79 - 1.28)
	Tertile 3	210	0.99 (0.82 - 1.20)	213	0.99 (0.83 - 1.19)	134	1.17 (0.96 - 1.42)	202	0.96 (0.80 - 1.15)	94	1.13 (0.91 - 1.41)
	Trend test		**P = 0.03**		P = 0.06		**P < 0.01**		P = 0.18		P = 0.10
Respiratory	Zero incidents	134	Ref	146	Ref	277	Ref	168	Ref	305	Ref
	Tertile 1	**65**	**0.68 (0.51 - 0.92)**	**62**	**0.73 (0.54 - 0.98)**	26	0.74 (0.50 - 1.12)	**46**	**0.62 (0.45 - 0.86)**	14	0.60 (0.35 - 1.03)
	Tertile 2	113	0.89 (0.69 - 1.14)	108	0.90 (0.70 - 1.16)	50	0.80 (0.59 - 1.08)	102	0.92 (0.72 - 1.18)	36	0.89 (0.63 - 1.26)
	Tertile 3	**84**	**0.72 (0.55 - 0.95)**	**80**	**0.68 (0.52 - 0.90)**	**43**	**0.68 (0.49 - 0.94)**	**80**	**0.68 (0.52 - 0.89)**	41	0.95 (0.68 - 1.31)
	Trend test		P = 0.87		P = 0.84		P = 0.22		P = 0.31		**P = 0.01**
Lung	Zero incidents	116	Ref	126	Ref	243	Ref	145	Ref	263	Ref
	Tertile 1	**54**	**0.66 (0.48 - 0.92)**	**50**	**0.69 (0.50 - 0.97)**	21	0.71 (0.45 - 1.11)	**39**	**0.62 (0.44 - 0.89)**	**12**	**0.62 (0.35 - 1.12)**
	Tertile 2	101	0.92 (0.70 - 1.19)	98	0.95 (0.73 - 1.24)	40	0.74 (0.53 - 1.03)	89	0.93 (0.71 - 1.21)	30	0.87 (0.60 - 1.28)
	Tertile 3	**73**	**0.73 (0.54 - 0.98)**	**70**	**0.69 (0.52 - 0.93)**	40	0.73 (0.52 - 1.02)	**71**	**0.70 (0.53 - 0.93)**	39	1.05 (0.75 - 1.48)
	Trend test		P = 0.72		P = 0.84		P = 1.00		P = 0.82		P = 0.11
Melanoma	Zero incidents	215	Ref	243	Ref	495	Ref	263	Ref	572	Ref
	Tertile 1	175	1.01 (0.83 - 1.23)	157	0.94 (0.77 - 1.16)	95	1.09 (0.87 - 1.36)	146	1.03 (0.84 - 1.27)	73	1.17 (0.91 - 1.50)
	Tertile 2	220	1.06 (0.88 - 1.28)	210	1.03 (0.86 - 1.24)	115	0.95 (0.77 - 1.16)	203	1.13 (0.94 - 1.36)	78	0.92 (0.73 - 1.17)
	Tertile 3	188	0.93 (0.76 - 1.13)	188	0.90 (0.75 - 1.09)	**93**	**0.76 (0.61 - 0.95)**	186	0.97 (0.80 - 1.17)	75	0.85 (0.67 - 1.08)
	Trend test		P = 0.41		P = 0.64		**P = 0.02**		P = 0.51		P = 0.06

Cancer Categories	Groups	O	All Incidents	O	All Fire Incidents	O	Structural Fire Incidents	O	Landscape Fire Incidents	O	Vehicle Fire Incidents
Male Reproductive	Zero incidents	663	Ref	724	Ref	1509	Ref	822	Ref	1791	Ref
	Tertile 1	452	0.95 (0.84 - 1.06)	416	0.97 (0.86 - 1.09)	192	1.00 (0.86 - 1.17)	372	1.01 (0.89 - 1.14)	126	0.93 (0.77 - 1.11)
	Tertile 2	686	1.08 (0.97 - 1.02)	640	1.07 (0.97 - 1.19)	354	1.02 (0.91 - 1.15)	569	1.04 (0.94 - 1.16)	232	0.96 (0.84 - 1.10)
	Tertile 3	616	1.04 (0.93 - 1.16)	637	1.06 (0.96 - 1.18)	362	1.03 (0.92 - 1.15)	654	1.10 (1.00 - 1.22)	268	1.03 (0.91 - 1.17)
	Trend test		P = 0.17		P = 0.15		P = 0.67		P = 0.13		P = 0.26
Prostate	Zero incidents	647	Ref	705	Ref	1459	Ref	800	Ref	1729	Ref
	Tertile 1	423	0.92 (0.81 - 1.04)	387	0.94 (0.83 - 1.07)	174	0.98 (0.84 - 1.15)	342	0.98 (0.86 - 1.11)	107	0.86 (0.71 - 1.05)
	Tertile 2	658	1.06 (0.95 - 1.19)	615	1.06 (0.95 - 1.18)	340	1.02 (0.91 - 1.15)	544	1.02 (0.92 - 1.14)	222	0.96 (0.83 - 1.10)
	Tertile 3	590	1.02 (0.91 - 1.14)	611	1.05 (0.94 - 1.17)	345	1.02 (0.90 - 1.14)	632	1.09 (0.98 - 1.21)	260	1.04 (0.91 - 1.18)
	Trend test		P = 0.14		P = 0.14		P = 0.66		P = 0.09		P = 0.09
Testis	Zero incidents	14	Ref	16	Ref	47	Ref	19	Ref	59	Ref
	Tertile 1	**28**	**2.02 (1.06 - 3.86)**	**29**	**2.09 (1.13 - 3.86)**	18	1.37 (0.79 - 2.37)	**30**	**2.19 (1.23 - 3.91)**	17	1.53 (0.89 - 2.64)
	Tertile 2	**28**	**2.17 (1.14 - 4.14)**	**25**	**1.93 (1.03 - 3.63)**	14	1.15 (0.63 - 2.10)	**25**	**1.96 (1.08 - 3.57)**	10	1.05 (0.54 - 2.06)
	Tertile 3	24	1.84 (0.95 - 3.58)	**24**	**1.90 (1.00 - 3.59)**	15	1.25 (0.70 - 2.24)	20	1.68 (0.89 - 3.17)	8	0.83 (0.40 - 1.75)
	Trend test		P = 0.71		P = 0.70		P = 0.75		P = 0.35		P = 0.16
Urinary tract	Zero incidents	81	Ref	90	Ref	182	Ref	99	Ref	201	Ref
	Tertile 1	47	0.81 (0.56 - 1.16)	40	0.75 (0.51 - 1.09)	20	0.82 (0.52 - 1.31)	39	0.87 (0.60 - 1.27)	18	1.12 (0.69 - 1.82)
	Tertile 2	79	1.03 (0.75 - 1.41)	78	1.06 (0.78 - 1.43)	33	0.80 (0.55 - 1.16)	69	1.05 (0.77 - 1.43)	32	1.19 (0.82 - 1.74)
	Tertile 3	74	1.05 (0.76 - 1.44)	73	1.01 (0.74 - 1.38)	46	1.10 (0.80 - 1.53)	74	1.07 (0.79 - 1.45)	30	1.05 (0.71 - 1.54)
	Trend test		P = 0.19		P = 0.17		P = 0.21		P = 0.33		P = 0.67
Kidney	Zero incidents	41	Ref	46	Ref	97	Ref	50	Ref	109	Ref
	Tertile 1	26	0.83 (0.51 - 1.36)	23	0.78 (0.47 - 1.29)	14	0.95 (0.54 - 1.67)	23	0.93 (0.57 - 1.54)	10	1.00 (0.53 - 1.92)
	Tertile 2	45	1.13 (0.74 - 1.72)	44	1.13 (0.75 - 1.72)	21	0.91 (0.56 - 1.45)	41	1.20 (0.79 - 1.82)	24	1.55 (1.00 - 2.42)
	Tertile 3	55	1.44 (0.96 - 2.17)	54	1.37 (0.93 - 2.05)	35	1.49 (0.01 - 2.20)	53	1.44 (0.98 - 1.13)	24	1.47 (0.94 - 2.29)
	Trend test		**P = 0.02**		**P = 0.02**		P = 0.08		P = 0.08		P = 0.45
Lympho-haematopoetic	Zero incidents	170	Ref	180	Ref	366	Ref	211	Ref	429	Ref
	Tertile 1	113	0.89 (0.70 - 1.12)	108	0.96 (0.75 - 1.22)	45	0.83 (0.61 - 1.13)	82	0.81 (0.62 - 1.04)	39	0.99 (0.71 - 1.39)
	Tertile 2	155	0.96 (0.77 - 1.19)	152	1.03 (0.83 - 1.27)	76	0.90 (0.70 - 1.15)	150	1.07 (0.86 - 1.32)	51	0.86 (0.65 - 1.16)
	Tertile 3	149	0.99 (0.79 - 1.23)	147	1.01 (0.81 - 1.25)	100	1.17 (0.94 - 1.46)	144	0.97 (0.79 - 1.21)	68	1.09 (0.84 - 1.40)
	Trend test		P = 0.40		P = 0.74		**P = 0.03**		P = 0.27		P = 0.50
NHL	Zero incidents	65	Ref	69	Ref	149	Ref	81	Ref	179	Ref
	Tertile 1	49	0.99 (0.68 - 1.44)	49	1.11 (0.77 - 1.61)	18	0.78 (0.48 - 1.27)	37	0.92 (0.62 - 1.36)	15	0.88 (0.52 - 1.51)
	Tertile 2	60	0.96 (0.68 - 1.37)	64	1.12 (0.79 - 1.57)	34	0.96 (0.66 - 1.39)	59	1.08 (0.77 - 1.51)	17	0.67 (0.41 – 1.10)
	Tertile 3	67	1.13 (0.80 - 1.59)	59	1.02 (0.72 - 1.45)	40	1.12 (0.79 - 1.59)	64	1.09 (0.78 - 1.52)	30	1.12 (0.76 - 1.65)
	Trend test		P = 0.47		P = 0.63		P = 0.19		P = 0.46		P =0.28

* Statistically significantly elevated RIR results and statistically significant positive trends are in **red**, statistically significantly reduced RIR results and statistically significant negative trends are in **blue**

Table 62: Relative Inc ident Ratios* and 95% confidence intervals for female volunteer firefighters to 31/12/2010 by number of incidents and incident types in tertiles (adjusted for age and calendar period) Trend test across individuals with incidents only

Cancer Categories	Groups	O	All Incidents	O	All Fire Incidents	O	Structural Fire Incidents	O	Landscape Fire Incidents	O	Vehicle Fire Incidents
All Malignancies	Zero incidents	418	Ref	445	Ref	653	Ref	478	Ref	682	Ref
	Tertile 1	119	0.98 (0.80 - 1.20)	122	1.03 (0.85 - 1.27)	40	0.74 (0.54 - 1.02)	103	1.06 (0.85 - 1.31)	40	1.04 (0.76 - 1.44)
	Tertile 2	145	1.03 (0.85 - 1.25)	122	1.01 (0.83 - 1.24)	64	1.02 (0.79 - 1.32)	109	0.95 (0.77 - 1.18)	42	0.96 (0.70 - 1.31)
	Tertile 3	138	1.14 (0.93 - 1.38)	131	1.14 (0.94 - 1.39)	63	1.04 (0.80 - 1.35)	130	1.18 (0.97 - 1.43)	56	1.29 (0.98 - 1.69)
	Trend test		P = 0.19		P = 0.39		P = 0.14		P = 0.38		P = 0.28
Lip, Oral Cavity & Pharynx	Zero incidents	8	Ref	9	Ref	12	Ref	10	Ref	13	Ref
	Tertile 1	1	0.42 (0.05 - 3.34)	2	0.80 (0.17 - 3.71)	1	0.91 (0.11 - 7.03)	2	0.90 (0.20 - 4.14)	0	-
	Tertile 2	5	1.75 (0.57 - 5.36)	3	1.16 (0.31 - 4.29)	1	0.78 (0.10 - 6.01)	2	0.81 (0.18 - 3.68)	1	1.07 (0.14 - 8.22)
	Tertile 3	1	0.38 (0.47 - 3.04)	1	0.39 (0.05 - 3.07)	1	0.80 (0.10 - 6.12)	1	0.40 (0.05 - 3.12)	1	1.06 (0.14 - 8.15)
	Trend test		P = 0.94		P = 0.61		P = 0.90		P = 0.52		P = 0.44
Digestive Organs	Zero incidents	70	Ref	71	Ref	96	Ref	79	Ref	106	Ref
	Tertile 1	16	0.88 (0.51 - 1.52)	15	0.91 (0.52 - 1.60)	8	1.32 (0.64 - 2.73)	10	0.74 (0.38 - 1.43)	8	1.87 (0.91 - 3.88)
	Tertile 2	23	1.09 (0.68 - 1.74)	23	1.32 (0.83 - 2.12)	11	1.40 (0.75 - 2.61)	21	1.21 (0.75 - 1.96)	7	1.24 (0.58 - 2.68)
	Tertile 3	22	1.35 (0.83 - 2.19)	22	1.46 (0.90 - 2.37)	**16**	**2.28 (1.34 - 3.90)**	21	1.35 (0.83 - 2.18)	10	1.87 (0.97 - 3.60)
	Trend test		P = 0.16		P = 0.15		P = 0.19		P = 0.12		P = 0.95
Colorectal	Zero incidents	57	Ref	58	Ref	78	Ref	65	Ref	86	Ref
	Tertile 1	11	0.74 (0.39 - 1.41)	11	0.81 (0.43 - 1.55)	6	1.20 (0.52 - 2.76)	7	0.62 (0.28 - 1.36)	7	1.98 (0.91 - 4.33)
	Tertile 2	20	1.15 (0.69 - 1.92)	19	1.33 (0.79 - 2.24)	10	1.55 (0.80 - 3.00)	17	1.18 (0.69 - 2.02)	6	1.30 (0.57 - 2.97)
	Tertile 3	18	1.34 (0.78 - 2.29)	18	1.45 (0.85 - 2.47)	12	**2.08 (1.13 - 3.84)**	17	1.31 (0.77 - 2.24)	7	1.59 (0.73 - 3.46)
	Trend test		P = 0.11		P = 0.13		P = 0.26		P = 0.11		P = 0.73
Respiratory	Zero incidents	28	Ref	30	Ref	52	Ref	33	Ref	53	Ref
	Tertile 1	10	1.25 (0.61 - 2.57)	10	1.27 (0.62 - 2.60)	0	-	10	1.52 (0.75 - 3.09)	1	0.38 (0.05 - 2.59)
	Tertile 2	11	1.17 (0.58 - 2.35)	9	1.11 (0.53 - 2.34)	6	1.21 (0.52 - 2.82)	5	0.64 (0.25 - 1.63)	3	0.90 (0.28 - 2.86)
	Tertile 3	13	1.60 (0.83 - 3.09)	13	1.69 (0.88 - 3.23)	4	0.84 (0.30 - 2.33)	14	1.82 (0.97 - 3.40)	5	1.50 (0.60 - 3.76)
	Trend test		P = 0.51		P = 0.46		P = 0.17		P = 0.56		P = 0.18
Lung	Zero incidents	27	Ref	29	Ref	51	Ref	32	Ref	52	Ref
	Tertile 1	10	1.29 (0.63 - 2.67)	10	1.31 (0.64 - 2.70)	0	-	10	1.57 (0.78 - 3.19)	1	0.36 (0.05 - 2.64)
	Tertile 2	11	1.21 (0.60 - 2.45)	9	1.15 (0.54 - 2.43)	6	1.23 (0.53 - 2.88)	5	0.66 (0.26 - 1.69)	3	0.91 (0.29 - 2.93)
	Tertile 3	13	1.66 (0.86 - 3.22)	13	1.74 (0.90 - 3.35)	4	0.86 (0.31 - 2.37)	14	1.87 (1.00 - 3.51)	5	1.53 (0.61 - 3.83)
	Trend test		P = 0.51		P = 0.46		P = 0.17		P = 0.56		P = 0.18
Melanoma	Zero incidents	61	Ref	66	Ref	99	Ref	71	Ref	97	Ref
	Tertile 1	20	1.04 (0.63 - 1.73)	21	1.10 (0.67 - 1.80)	5	0.53 (0.21 - 1.30)	18	1.11 (0.66 - 1.87)	9	1.38 (0.69 - 2.75)
	Tertile 2	18	0.82 (0.48 - 1.38)	13	0.68 (0.37 - 1.23)	7	0.66 (0.31 - 1.43)	12	0.67 (0.36 - 1.23)	5	0.72 (0.29 - 1.76)
	Tertile 3	17	0.84 (0.49 - 1.44)	16	0.84 (0.48 - 1.45)	5	0.47 (0.19 - 1.17)	15	0.83 (0.48 - 1.46)	5	0.71 (0.29 - 1.75)
	Trend test		P = 0.53		P = 0.42		P = 0.89		P = 0.41		P = 0.24

Cancer Categories	Groups	O	All Incidents	O	All Fire Incidents	O	Structural Fire Incidents	O	Landscape Fire Incidents	O	Vehicle Fire Incidents
Female Reproductive	Zero incidents	32	Ref	35	Ref	55	Ref	35	Ref	56	Ref
	Tertile 1	9	0.97 (0.46 - 2.05)	8	0.87 (0.40 - 1.89)	0	-	8	1.15 (0.53 - 2.49)	2	0.66 (0.16 - 2.72)
	Tertile 2	11	1.04 (0.53 - 2.08)	9	0.96 (0.46 - 2.01)	6	1.16 (0.50 - 2.70)	9	1.09 (0.52 - 2.27)	3	0.86 (0.27 - 2.76)
	Tertile 3	15	1.70 (0.91 - 3.16)	15	1.74 (0.94 - 3.21)	6	1.22 (0.52 - 2.85)	**15**	**1.92 (1.05 - 3.54)**	6	1.76 (0.75 - 4.10)
	Trend test		P = 0.16		P = 0.09		P = 0.06		P = 0.18		P = 0.18
Urinary tract	Zero incidents	12	Ref	12	Ref	14	Ref	13	Ref	15	Ref
	Tertile 1	0	-	0	-	0	-	0	-	0	-
	Tertile 2	3	0.74 (0.21 - 2.61)	3	0.92 (0.26 - 3.25)	1	0.74 (0.10 - 5.60)	2	0.64 (0.14 - 2.85)	2	2.06 (0.47 - 9.02)
	Tertile 3	4	1.12 (0.36 - 3.48)	4	1.26 (0.41 - 3.93)	4	3.04 (1.00 - 9.27)	4	1.29 (0.42 - 3.97)	2	2.06 (0.47 - 9.03)
	Trend test		P = 0.09		P = 0.09		P = 0.08		P = 0.09		P = 0.31
Kidney	Zero incidents	10	Ref	10	Ref	12	Ref	11	Ref	13	Ref
	Tertile 1	0	-	0	-	0	-	0	-	0	-
	Tertile 2	3	0.87 (0.24 - 3.18)	3	1.09 (0.30 - 3.95)	1	0.85 (0.11 - 6.51)	2	0.75 (0.17 - 3.40)	1	1.17 (0.15 - 8.96)
	Tertile 3	3	0.99 (0.27 - 3.60)	3	1.12 (0.31 - 4.09)	3	2.61 (0.73 - 9.31)	3	1.14 (0.32 - 4.08)	2	2.33 (0.52 - 10.39)
	Trend test		P = 0.16		P = 0.16		P = 0.13		P = 0.16		P = 0.24
Lympho-haematopoetic	Zero incidents	37	Ref	40	Ref	59	Ref	45	Ref	61	Ref
	Tertile 1	16	1.46 (0.81 - 2.63)	16	1.47 (0.82 - 2.64)	3	0.58 (0.18 - 1.86)	13	1.36 (0.73 - 2.53)	4	1.08 (0.39 - 2.99)
	Tertile 2	10	0.78 (0.39 - 1.57)	8	0.71 (0.33 - 1.53)	5	0.84 (0.34 - 2.09)	8	0.73 (0.34 - 1.55)	4	0.97 (0.35 - 2.67)
	Tertile 3	10	0.88 (0.44 - 1.79)	9	0.84 (0.41 - 1.74)	6	1.03 (0.44 - 2.41)	7	0.66 (0.30 - 1.47)	4	0.97 (0.35 - 2.69)
	Trend test		P = 0.18		P = 0.14		P = 0.44		P = 0.11		P = 0.91
NHL	Zero incidents	16	Ref	18	Ref	28	Ref	21	Ref	25	Ref
	Tertile 1	6	1.20 (0.47 - 3.08)	7	1.35 (0.56 - 3.24)	1	0.38 (0.05 - 2.79)	4	0.84 (0.29 - 2.47)	3	1.86 (0.56 - 6.20)
	Tertile 2	6	1.04 (0.41 - 2.66)	3	0.57 (0.17 - 1.95)	1	0.34 (0.05 - 2.49)	5	0.94 (0.36 - 2.50)	3	1.71 (0.51 - 5.67)
	Tertile 3	5	0.95 (0.35 - 2.61)	5	0.98 (0.36 - 2.64)	3	1.03 (0.31 - 3.39)	3	0.57 (0.17 - 1.92)	2	1.12 (0.27 - 4.76)
	Trend test		P = 0.73		P = 0.54		P = 0.33		P = 0.62		P = 0.59

* Statistically significantly elevated RIR results are in **red**

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