Introduction

This report describes the results of the Australian Gulf War Veterans’ Follow Up Health Study; a longitudinal cohort study of the physical, psychological and social health and military related exposures of Australian Defence Force (ADF) veterans of the 1990-1991 Gulf War and a comparison group also drawn from the ADF. The findings build upon those of the baseline 2000-2002 Australian Gulf War Veterans’ Health Study.

The Australian Gulf War Veterans’ Follow Up Health Study has been conducted by a collaborative medical research team headed by Professor Malcolm Sim, Director, Monash Centre for Occupational and Environmental Health. An Advisory Committee, with representatives from several veteran and service bodies, was established to provide a link between the researchers and the veteran and service communities. The Follow Up Health Study protocol was approved by the Ethics Committees of Monash University, the Australian Government Department of Veterans’ Affairs (DVA) and the ADF. Additional ethical approval was obtained from the Australian Institute of Health and Welfare, those Ethics Committees which preside over the various Australian State and Territory cancer registries and the Department of Human Services External Request Evaluation Committee, for those aspects of the study protocol relevant to those Committees.

Data collection for the Australian Gulf War Veterans’ Follow Up Health Study was conducted in the period 2011-2013, approximately ten years after the baseline study. The Follow Up Health included linkage of the entire cohort to the Australian national mortality and cancer registries and a health survey which included an extensive health questionnaire, over-the-phone psychological health interview and linkage to Medicare and DVA health databases.

The aims of the Australian Gulf War Veterans’ Follow Up Health Study were to investigate:

- whether Gulf War veterans have a greater risk of death or of developing cancer than the comparison group or the Australian community;
- the prevalence, at follow up, of a number of health outcomes that were in excess during the baseline study, in particular symptom reporting and multisymptom illness, chronic fatigue, gastrointestinal disorders including irritable bowel syndrome, depression, posttraumatic stress disorder (PTSD) and alcohol disorders;
- the change in prevalence of these health outcomes since the baseline study;
- the pattern of persistence or new incidence of these health outcomes;
- the prevalence of some additional adverse health outcomes, which were not assessed at baseline, including pain, sleep disturbance, injury, musculoskeletal disorders and demoralisation;
- the current levels of general well-being and social functioning, including quality of life, life satisfaction, life events, financial distress, suicidal ideation and community participation in Gulf War veterans and the comparison group; and
- the association between deployment related exposures during the Gulf War and health outcomes at follow up in Gulf War veterans.

**Recruitment**

All participants from the baseline 2000-2002 Australian Gulf War Veterans’ Health Study were eligible to participate in the Follow Up Health Study. Recruitment commenced in October 2011 and closed in August 2012. Follow Up Health Study participants were 715 Gulf War veterans (54% recruitment rate) and 675 comparison group members (47% recruitment rate). The results presented for health outcomes throughout the report are limited to men who represented 98% of all participants in both study groups. Male participants ranged from 38 to 72 years of age and averaged approximately 50 years. Gulf War veterans averaged 20 years of regular ADF service at follow up, whilst the comparison group averaged 21 years. Gulf War veteran participants were more likely to have served in the Navy (86%) than the comparison group (68%). The two groups were equally likely to have separated from the ADF with only one in six still serving. Since the baseline study they were also equally likely to have deployed for at least one month on a major ADF Operation and to have served in a combat role.

**Summary of Follow Up Health Study Findings**

**Symptoms and multisymptom illness**

At both baseline and follow up, participants completed the same 63-item past-month health symptom checklist. At follow up the Gulf War veterans reported an average of 17 of 63 general health symptoms whereas the comparison group averaged 12 symptoms. Gulf War veterans reported 62 of 63 general health symptoms more frequently than the comparison group, and for 47 of those symptoms the increase was statistically significant. Since baseline, individual symptoms were more likely to have persisted in Gulf War veterans (i.e. present at baseline and at follow up) and more likely to be incident in Gulf War veterans (i.e. present at follow up when absent baseline), than in the comparison group.

Whilst the Gulf War veterans reported health symptoms with greater frequency than the comparison group at follow up, the pattern of co-occurrence of symptoms reported at follow up by the two groups was similar, as assessed through factor analysis of symptoms. Analogous to the result found at baseline, this suggested that the pattern (but not frequency) of self-reported symptoms among Gulf War veterans was not unique.
Based on two alternative definitions of multisymptom illness, the prevalence of multisymptom illness in Australian Gulf War veterans at follow up ranged from 26 to 29% and these represented an excess risk of 60% relative to the comparison group.

**Fatigue and chronic fatigue**

Three measures of fatigue of increasing duration/severity, those being: ‘extreme tiredness or fatigue following normal activities’, ‘prolonged extreme tiredness or fatigue of at least one month’ and ‘chronic extreme tiredness or fatigue of at least six months’ were present in 33%, 17% and 12% of Australian Gulf War veterans respectively at follow up. Relative to the comparison group, Gulf War veterans were at significantly increased risk of each of these three fatigue-related outcomes by between 37% and 41%. In both study groups, prevalence of these fatigue outcomes roughly doubled from baseline to follow up, and there were no significant differences between the study groups in persistence or incidence.

**Irritable bowel syndrome**

At follow up, 13% of Gulf War veterans and 8% of the comparison group met diagnostic criteria for irritable bowel syndrome, representing an increased relative risk in Gulf War veterans of 64%.

**Musculoskeletal disorders**

At follow up there was no significant excess of self-reported doctor diagnosed, or treated, musculoskeletal disorders in Australian Gulf War veterans relative to the comparison group, including osteoarthritis, rheumatoid arthritis, other inflammatory arthritis, gout or osteoporosis. The most prevalent disorder was osteoarthritis, reported by one in seven participants, and this most frequently manifested in the knee relative to the other body sites.

**Pain**

Debilitating pain in the previous six months was highly prevalent in both study groups, with approximately one in five Gulf War veterans and one in six comparison group participants reporting pain graded as high in disability and moderately or severely limiting. From a list of 19 body areas, Gulf War veterans were one and a half times more likely than comparison group participants to report between four and six body areas of pain or tenderness in the seven days prior to follow up, and more than two and a half times more likely to report 11 or more body areas of pain or tenderness.

**Reproductive outcomes**

Gulf War veterans were more likely than the comparison group to report difficulty fathering a pregnancy since January 1992, less likely to report that a cause for their infertility had been found, but equally likely to have sought or undertaken infertility treatment and equally likely
to have fathered a pregnancy. About one half of all participants had fathered a pregnancy in the period since 1992. Approximately 80% of pregnancies were reported to have resulted in a live birth and 87% of live birth babies were full-term and normal birth weight; these did not differ between study groups.

**Sleeping pattern and daytime sleepiness**
Gulf War veterans were significantly more likely than the comparison group to report difficulty falling asleep, staying asleep and, to some extent, staying awake. Overall levels of daytime sleepiness were similar between the two study groups. Approximately 10% of participants in both groups reported doctor diagnosed, or treated, sleep apnoea, and this was roughly triple the prevalence reported at baseline.

**Respiratory health**
At follow up, a number of respiratory symptoms were reported significantly more frequently by Gulf War veterans than the comparison group. The greatest excess was for morning cough, where risk in the veteran group was elevated by 67%, followed by 44% for wheeze, 38% for morning sputum in winter and about 36% for day or night time cough. The differences between the two groups on self-reported doctor-confirmed respiratory medical conditions were not statistically significant, however the pattern was such that asthma, chronic bronchitis and emphysema or chronic obstructive pulmonary disease were all reported more frequently by Gulf War veterans.

**Neuropathic symptoms**
Participants in both study groups averaged two of the 17 neuropathic symptoms measured. Gulf War veterans were significantly more likely than the comparison group, however, to report at least one neuropathic symptom (60% vs 52%) or at least four neuropathic symptoms (24% vs 18%), one or more symptom of muscle weakness (44% vs 36%) and one or more symptom of sensory disturbance (45% vs 39%).

**Self-assessed physical health**
At follow up, the Gulf War veterans reported poorer self-assessed physical health status than the comparison group, and this health difference between the two study groups was very slightly wider than that observed at baseline.

**Posttraumatic stress disorder (PTSD)**
Using three different measures, the risks of PTSD at follow up in Gulf War veterans were between one and a half and three times greater than the risks in the comparison group. Approximately 7% to 8% of Gulf War veterans met criteria for PTSD relative to about 3% to 5% of the comparison group. Since the baseline study, new (incident) cases of PTSD were more likely to occur in Gulf War veterans than in the comparison group. There was also a
pattern of PTSD being more likely to persist, and less likely to remit, in Gulf War veterans relative to the comparison group, however those findings did not reach statistical significance. The gap between the two groups in PTSD-related morbidity had, therefore, widened since baseline.

**Alcohol disorder**
The risk of alcohol disorder at follow up, using three measures, was estimated to be one and a quarter to two times higher in the veteran group relative to the comparison group. Based on a diagnostic interview, the risk of 12 month alcohol disorder in Gulf War veterans had approximately doubled in the 10 year period since baseline, and this was a statistically significant increase. The risk of alcohol disorder in the comparison group had also increased but not significantly so.

**Major depression**
The prevalence of 12 month major depression, at follow up, was almost 10% in the Gulf War veterans and almost 8% in the comparison group. This difference between groups was not statistically significant. There were, however, other indicators of increased depressive morbidity amongst Gulf War veterans relative to the comparison group. Gulf War veterans (11.2%) were more likely than the comparison group (6.5%) to have been dispensed an anti-depressive medication in the previous 12 months and Gulf War veterans were also more likely, than the comparison group, to report depression symptoms at follow up which were mild or moderate in severity, and less likely to report symptoms of minimal severity.

**Other psychological health indicators**
Relative to the comparison group, Australian Gulf War veterans reported significantly poorer mental health status, greater risk of general psychological distress, and higher levels of demoralisation. Further, risk of feeling that life was not worth living was elevated by 40% and risk of making a suicide plan was elevated by 144% in Gulf War veterans. Importantly, actual suicide rates among Gulf War veterans were not elevated. A further finding was that the two study groups were found to be equally resilient.

**Injuries**
A little more than one third of participants, in both study groups, reported at least one injury in the past 12 months, which was severe enough to interfere with their daily activities. The most prevalent event type leading to injury was falls of less than a metre (22% Gulf War veterans and 15% comparison group) and this difference between groups was statistically significant. The two study groups did not differ in regard to the activity types to which their injuries were attributed; the most frequently reported being sport, with one third of recent injuries attributed to this.
Life events
There were no differences between the two study groups on measures of their exposure to traumatic life events, financial strain, homelessness and incarcerations. Therefore, differences in life experiences of these kinds between the study groups do not appear to be an explanation for the excess of PTSD, alcohol disorder or other adverse psychological health indicators in the Australian Gulf War veterans. Conversely, the excess of morbidity in Gulf War veterans does not appear to be resulting in increased exposure to traumatic life experiences.

Life satisfaction and quality of life
General measures of life satisfaction, health satisfaction and overall quality of life were similar in the two study groups. However, Gulf War veterans reported significantly poorer quality of life on a number of measured domains including Physical Health, which comprised items such as ability to perform activities of daily living and mobility, also on the Psychological domain comprising items such as self-esteem, concentration, negative mood and body image, and the Social Relationships domain comprising items such as personal relationships and social support. Gulf War veterans did not, however, report poorer quality of life on the Environment domain. This latter domain, comprising items such as financial resources, transport, safety and access to information would seem less likely to be influenced by the adverse health outcomes, which were in excess in the veteran group, than the other domains.

Social health
The social health of Gulf War veterans at follow up was similar to that in the comparison group, based on our measures of functional and structural social support, community participation and involvement in military related organisations and commemorations. Considering the excess of physical and psychological morbidities in Gulf War veterans observed in this follow up study, it was a positive finding that they were functioning as well socially as their comparators. Ongoing chronicity of adverse health outcomes however, is a factor that could contribute to a decline in the social health of Gulf War veterans over time.

Health services utilisation and DVA healthcare support
Gulf War veterans, relative to the comparison group, had a significantly increased rate of lodging disability claims with DVA and increased likelihood of having had at least one claim accepted, an increased rate of DVA hospitalisation, increased likelihood of having been issued a Gold Card and an increased number of pharmaceutical scripts filled in the past 12 months. There was no observable difference, however, in the two study groups’ likelihood of having accessed general practitioners, medical specialists such as neurologists,
gastroenterologists, respiratory physicians and psychiatrists and allied health professionals such as physiotherapists, chiropractors or naturopaths.

**Health risk factors**
The health risk factors that were investigated in the study included health behaviours such as smoking, physical activity and dietary behaviour, and biomedical factors including body weight, body mass index and waist circumference. On the whole, the two study groups were similar in regard to these measures, suggesting that these determinants of health were not driving the excess morbidity observed in Gulf War veterans. There had been a very large reduction in the tobacco smoking rate since baseline; one half of those who reported being smokers at baseline were no longer smokers at follow up.

**Health status and health service utilisation at follow up for participants with disorders at baseline**
Multisymptom illness, chronic fatigue, and 12-month major depression, PTSD and alcohol use disorder, were outcomes found to be in excess in the Gulf War veteran group at baseline. In the follow up study, approximately ten years later, we found that the presence of one or more of these disorders at baseline has led to substantially poorer general health and well-being and greater health service utilisation at follow up in both study groups, and increased DVA disability claims in the Gulf War veteran group.

**Extended exposure assessment**
In the baseline study, Gulf War exposure assessment was based largely on each participant’s self-reported experience of a number of exposures, such as dust storms, smoke and oil from burning oil-wells (SMOIL), pesticides, biological or chemical weapons, and vaccinations and prophylactic medications such as pyridostigmine bromide (PB). For the purpose of the follow up study, and to augment the exposure data which had already been collected by self-report methods at baseline, several additional sources of information relevant to Gulf War exposures were reviewed. These included the Reports of Proceedings (RoPs), Ships’ Logs and Ships’ Medical Journals for the Ships which deployed as part of the Gulf War, and other reports. An additional strategy used at follow up, to supplement the self-reported exposure information collected at baseline, was to document the pattern of exposures reported across each ship’s complement and other group deployed to the Gulf War. The purpose of this was to determine whether the personnel on any ship or other deployed group could be collectively categorised as belonging to a particular stratum of exposure.
Patterns of association between Gulf War deployment characteristics and exposures, and health outcomes at follow up

Several Gulf War deployment characteristics and exposures were associated with a number of adverse health outcomes at follow up in Gulf War veterans, including:

- lower rank at the time of Gulf War deployment was significantly associated with poorer perceived physical health status and increased risk of multisymptom illness, neuropathic symptom reporting, irritable bowel syndrome, and 12-month alcohol disorder;
- Army service was marginally significantly associated with PTSD, however this was based on a small number of cases;
- self-reported taking of PB tablets was associated with increased symptom reporting, risk of multisymptom illness and irritable bowel syndrome at follow up;
- self-reported number of vaccinations was associated in a dose response relationship with increased symptom reporting, risk of multisymptom illness and chronic fatigue; with the greatest risk amongst Gulf War veterans who reported ten or more vaccinations;
- self-reported pesticide exposure was associated with poorer perceived physical health status, and increased symptom reporting, risk of multisymptom illness and chronic fatigue;
- self-reported SMOIL exposure was associated in a dose response relationship with poorer perceived physical health status and increased symptom reporting.
- deployment which included the combat phase of the Gulf War was associated with increased symptom reporting and risk of multisymptom illness, increased depressive symptom severity and increased risk of major depression;
- an increasing number of self-reported deployment-related stressors was associated in a dose response relationship with poorer perceived mental health status, increased health symptom and neuropathic symptom reporting, increased risk of multisymptom illness, chronic fatigue, irritable bowel syndrome, major depression, PTSD, alcohol use and psychological distress at follow up; and
- there were no clear patterns of association between anti-malarials, dust storms, oil in water, intense smoke, or possible exposure to gastroenteritis outbreaks during the Gulf War and health outcomes at follow up.

There were a number of ways in which the above-listed exposures overlapped with each other during the Gulf War, therefore limiting the certainty with which any one exposure could conclusively be linked to any one health outcome.
Mortality and Cancer Incidence Study

The cohort included in the mortality and cancer incidence study totalled 4,793 members, comprising the entire deployed group of 1,871 Gulf War veterans and 2,922 comparison group members. Data was obtained from the National Death Index for the period 1st January 1991 to 30th of November 2010 for mortality, and from the Australian Cancer Database for the period 1st January 1991 to 31st of December 2008 for cancer incidence.

In the 20 year period following the Gulf War, there was a total of 108 deaths, comprising 2% of the total male cohort. Proportionately there have been slightly fewer deaths in total in the Gulf War veteran group compared to the same aged Australian male population and slightly more deaths in the Gulf War veterans relative to the comparison group, however these did not achieve statistical significance. In the same time period, ‘all-cause’ mortality rates, and mortality from ‘all external causes’, have been statistically significantly lower in the male comparison group than in the same aged Australian male population.

In the 18 year period following the Gulf War, there were 115 cancers detected; affecting 2.5% of the total male cohort. When all cancer types were combined, there was almost exactly the same number of cancers observed in the Gulf War veteran group as that expected in the Australian male population. There were slightly fewer cancers observed in the comparison group than expected. The risk of cancer in the Gulf War veterans was very slightly higher than in the comparison group. The numbers of cancers were very small when sub-grouped by cancer-type, making further interpretation of the results limited. The most frequently detected cancer type was melanoma in both study groups, with 25 cases in total. Thyroid cancer was statistically significantly in excess in the comparison group relative to the Australian population, however that finding was based on only five cases and should be interpreted with some caution. A five-fold increase in brain cancer observed in Gulf War veterans relative to the comparison group was not statistically significant and was based on less than five cases, but warrants further monitoring.

Strengths and Limitations

The strengths of the Australian Gulf War Veterans’ Follow Up Health Study include:

- the inclusion of a large military comparison group providing a benchmark against which the health of the Gulf War veterans can be compared;
- the matching of the two study groups on age-category, rank category and service branch, plus additional statistical adjustment for these and other factors, rendering it unlikely that such factors could explain post-Gulf War health differences;
• the inclusion of the entire cohort of Gulf War veterans in mortality and cancer data linkage, therefore minimising risk of participation bias in relation to mortality and cancer findings;
• participation rates which were comparable or better than other recent Gulf War studies;
• the use of baseline health data to compare Follow Up Health Study participants with non-participants, to assess the extent to which participants were representative of the study groups from which they were drawn;
• the use of well validated health instruments, evidence-based algorithms for detecting likely cases of symptom-based illnesses, repeated measures so that change since baseline could be assessed and objectively collected health service utilisation data for up to ten years in the past; and
• the use of Gulf War deployment exposure information collected at baseline, rather than more than 20 years after deployment, supplemented by a review of additional documentation.

Limitations of the Australian Gulf War Veterans’ Follow Up Health Study include:

• the limited power of the study to detect excess mortality and cancer because the cohort was still quite young at the date of mortality data linkage and the period of follow up was still relatively short for the purpose of detecting disease-related deaths for cancers of long-latency;
• the lower participation rate than that achieved at baseline, which has limited the ability of the Follow Up Health Study to draw meaningful conclusions about health outcomes with low prevalence and to address research questions in relation to the factors predicting persistence or recovery from some disorders; and
• the fact that the Pharmaceutical Benefits Scheme and Repatriation Pharmaceutical Benefits Scheme data do not capture all types of medications, and the number of scripts dispensed according to these databases may not have been the same as the number of scripts written by medical practitioners nor the same as the number of medications actually taken by participant.

Implications for Policy and Programs

The follow up study findings highlight the importance of:

• effective detection and management of existing chronic conditions in Australian Gulf War veterans such as multisymptom illness, chronic fatigue syndrome, irritable bowel syndrome, PTSD and alcohol disorder;
• ongoing monitoring of Gulf War veterans for the purpose of early detection and prevention of long-latency diseases, such as some cancers, or disorders for which rates appear to be on the rise in Gulf War veterans such as PTSD and sleep apnoea;
• improved awareness among health practitioners, of the types of health conditions and other problems known to occur more commonly in Gulf War veterans;
• improved strategies to target psychological health, including suicide prevention;
• programs and interventions that effectively maintain and bolster Gulf War veterans’ social health, particularly functional social support;
• programs aimed at positively changing health behaviours; and
• greater recognition in Australia of Gulf War-related multisymptom illness.

Implications for Future Research

Rather than a continued focus on the difference in health between Gulf War veterans and peers, future Gulf War veteran research might consider measuring the extent to which health interventions, improved detection of adverse health outcomes and policy change have alleviated or slowed the excess in risk in Gulf War veterans. The Australian Gulf War Veterans’ Health Study was designed as a prospective cohort study and future monitoring of the Gulf War veterans and comparison group, with a focus on repeat linkages with the National Death Index, Australian Cancer Database, Medicare, PBS and DVA data would continue to provide useful information relating to temporal trends in the health of Gulf War veterans over time and the effectiveness of interventions.

In regard to research involving future deployments, these are likely to be facilitated by collecting a ‘minimum dataset’ on all ADF personnel prior to deployment, more complete recording of relevant exposures, recruitment into studies early in the post-deployment period and increased mechanisms for data linkage to monitor patterns of health and associated outcomes, with regular contact to collect other variables not available through data linkage.