

Australian Gulf War Veterans' Follow Up Health Study

Summary Report 2015



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Advisory Committee

The role of the Advisory Committee was to:

- act as a mechanism for consultation and communication between the DVA, the researchers and the veteran community about issues relating to the study;
- represent veterans' interests and provide a veteran community perspective on issues relating to the study;
- observe the progress of the study and report back to the wider veteran community; and
- provide a mechanism for knowledge dissemination of the study findings.

A number of organisations were represented on the Advisory Committee. The findings presented in this Report do not necessarily reflect the views and opinions of the Advisory Committee members nor the organisations which they represented. Those Advisory Committee members who agreed that their names, and the name of their organisation, be included in this Report are shown below along with their dates of service on the Committee:

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Ethics Committees

The following ethics committees have approved all aspects of the Gulf War Veterans' Follow Up Health Study:

Monash University Human Research Ethics Committee

Australian Defence Human Research Ethics Committee

Department of Veterans' Affairs Human Research Ethics Committee

The following ethics committees have approved the linkage with the Australian Cancer Database and, in the case of AIHW, the linkage with the National Death Index:

Australian Capital Territory Health Human Research Ethics Committee

Australian Institute of Health and Welfare

Cancer Council Victoria's Human Research Ethics Committee

Department of Health Western Australia Human Research Ethics Committee

New South Wales Population and Health Services Research Ethics Committee

Queensland Health Human Research Ethics Committee

South Australia Human Health Research Ethics Committee

Tasmania Health Human Research Ethics Committee

The following ethics committees have approved the Medicare and Pharmaceutical Benefits Scheme linkage:

Department of Human Services External Request Evaluation Committee

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1 Background

In support of United Nations Security Resolutions subsequent to Iraq's invasion of Kuwait on the 2nd August 1990, a coalition of 41 countries, including Australia, mobilised a force of almost one million soldiers.¹ After many months of tension, intense air attacks against Iraqi forces began on the 16th January 1991. These were followed by the launch of a ground attack on the 24th February 1991 which ended in the defeat of the Iraqi forces as few as four days later. A formal ceasefire was declared by the United Nations on the 12th April 1991. Australia's deployment included 1,871 Australian Defence Force (ADF) personnel, predominantly Royal Australian Navy (Navy) personnel (84%), and also small groups of Australian Army (Army) and Royal Australian Air Force (Air Force), deployed between 2nd August 1990 and 4th September 1991. The Navy contingent included personnel on Her Majesty's Australian Ship (HMAS) *Darwin*, HMAS *Adelaide* and HMAS *Success* deployed in Operation Damask I; HMAS *Brisbane*, HMAS *Sydney* and HMAS *Westralia* deployed in Operation Damask II; HMAS *Darwin* deployed in Operation Damask III; Clearance Diving Team 3; and Task Group Medical Support Element (TGMSE) deployed to USNS *Comfort*. The Royal Australian Air Force (Air Force) supplied transport and logistic support but did not fly combat missions. Other ADF personnel who were involved in Gulf operations included intelligence officers (mainly Air Force but some Navy and Australian Army) and Army linguists. Some individual officers (mainly Army) were on secondment to United Kingdom (UK) and United States of America (USA) forces and deployed to the region with those forces. Other ADF deployments in the region at this time included Operation Habitat and Operation Blazer.

Soon after repatriation, coalition Gulf War veterans began reporting a variety of symptoms and illnesses which they attributed to their Gulf War service but which could not be readily explained by medical science.² The media coined the term "Gulf War Syndrome" shortly after.³ Most early health research was carried out on Gulf War veterans from the United States (US),⁴⁻⁶ however other coalition nations followed with studies of Gulf War veterans of the United Kingdom (UK),⁷ Canada,⁸ and Denmark⁹ among others.

During the decade following the Gulf War, Australian Gulf War veterans became increasingly concerned about the effects of that war upon their own health. Included amongst the Australian Gulf War veterans' numerous health concerns were reports of joint pain, headaches, stomach cramps, shortness of breath, skin problems, nightmares, fatigue, short

term memory problems, irritability, mood swings, depression, suicidal thoughts, loss of sexual libido, increased startle response and clumsiness.¹⁰

In the period 2000-2002, the Australian Gulf War Veterans' Health Study was undertaken by a research team based predominantly at the Monash University Centre for Occupational and Environmental Health (MonCOEH). This baseline health study included the entire cohort of Australia's 1,871 Gulf War veterans and a comparison group of 2,924 ADF, or formerly ADF, personnel who had been in operational units at the time of the Gulf War but who had not deployed to that conflict. The baseline study included extensive self-reported health and exposure data, also health data collected via face to face medical and psychological examinations, all-cause mortality and cancer incidence data sourced from Australian national registries and some ADF service-related data collated from records maintained by the DVA.

The baseline study found that, ten years after the Gulf War, veterans were at significantly greater risk than the comparison group of a number of adverse health outcomes including fatigue and chronic fatigue, multisymptom illness, posttraumatic stress disorder (PTSD), major depression, alcohol disorder, self-reported doctor-diagnosed medical conditions including gastrointestinal disorders and skin conditions, and numerous self-reported health symptoms. The Gulf War veterans rated their general physical health status and mental health status to be poorer than in the comparison group. The numbers of deaths and cancers in the cohort were small and lower than those expected based on rates in the general Australian population. Relative to the comparison group, there was a small excess of disease-related deaths in the veteran group, however the numbers were too small at that time to draw meaningful conclusions. Objective measures of health included in the baseline study, such as haematological, biochemical and serology tests, urinalysis, blood pressure and an exercise fitness test, did not differ between the two study groups. A number of Gulf War deployment-related characteristics and exposures were found to be associated with health outcomes in Gulf War veterans, particularly the reported numbers of vaccinations, pyridostigmine bromide tablets (PB) and deployment-related stressors.

Included among the recommendations arising from the results of the baseline Australian Gulf War Veterans' Health Study, was the recommendation that consideration be given to undertaking follow up studies, especially in relation to the cohort mortality and cancer incidence study, but also in relation to some of the health outcomes found in excess in Gulf War veterans, such that the longer term health sequelae of the Gulf War deployment could be monitored. In its most recent review of the vast health literature on Gulf War veterans internationally, the US Institute of Medicine (IOM) recommended longitudinal monitoring of

robust cohorts to carefully track the development of neurological and psychiatric conditions, also brain cancer and other long latency cancers, and additional health issues that occur at later age such as cardiovascular disease.¹¹ The IOM specifically mentioned the usefulness of the Australian cohort for tracking frequently seen health outcomes such as ‘Gulf War illness’ (also termed multisymptom illness), cardiovascular and respiratory diseases, other cancer types, and some psychiatric disorders.¹¹

This report summarises the findings from the first follow up study of the health of the members of the baseline Australian Gulf War Veterans’ Health Study cohort. This Australian Gulf War Veterans’ Follow Up Health Study comprises two primary components; a study of all-cause mortality and cancer-incidence in the entire cohort using data sourced from Australian national mortality and cancer registries, and a study of the health of those members of the cohort who participated in the baseline health study using data collected by self-report postal questionnaire, over-the-phone interview and linkage with Medicare and DVA health data. The Australian Gulf War Veterans’ Follow Up Health Study has been funded under a services agreement through the DVA competitive Applied Research Program. The research has been conducted by MonCOEH researchers and collaborators.

2 Australian Gulf War Veterans' Follow Up Health Study Aims

This Australian Gulf War Veterans' Follow Up Health Study was primarily designed to examine the physical, psychological and social health sequelae of deployment to the 1990-1991 Gulf War, amongst Australian veterans of that conflict more than 20 years after deployment. The findings are intended to build upon the results of the baseline Australian Gulf War Veterans' Health Study.

More specifically, the follow up study aimed 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 study also aimed to investigate 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, PTSD and alcohol disorders. The change in prevalence of these health outcomes since the baseline study, as well as the pattern of persistence or new incidence of these health outcomes, were also of interest.

The follow up health survey also aimed to investigate some additional adverse health outcomes, which were not included at baseline. These included pain, sleep disturbance, injury, musculoskeletal disorders and demoralisation.

In order to obtain a more detailed overview of the full impact of Gulf War deployment on the lives of Gulf War veterans, the follow up study also aimed to investigate a number of measures of well-being and social functioning, including quality of life, life satisfaction, life events, financial distress, suicidal ideation and community participation.

Finally, the follow up study aimed to investigate the association between Gulf War exposures and health outcomes at follow up. This included an extension of the exposure assessment methods which were utilised at baseline.

3 Study Design, Data Collection and Analysis

The Australian Gulf War Veterans' Follow Up Health Study was a longitudinal cohort study of the military-related exposures and the physical, psychological and social health of ADF veterans of the 1990-1991 Gulf War and a comparison group also drawn from the ADF.

Data collection for the Australian Gulf War Veterans' Follow Up Health Study was conducted in the period 2011-2013. This study included linkage of the entire cohort to the national mortality and cancer registries and a health survey of participants from the baseline health study which included linkage to Medicare- and DVA-held health databases.

Participants in the health survey were offered the option of participating in any, or all, of four study components, which included:

- i. a postal questionnaire including questions about demographics, military service, numerous health outcomes, health behaviours, life events and social functioning. A list of all instruments included in the questionnaire is provided in the Technical Report;
- ii. the Composite International Diagnostic Interview (CIDI) conducted over-the-phone to assess presence of psychological disorders;
- iii. consent for the researchers to access their DVA-held health data; and
- iv. consent for the researchers to access their Medicare, Pharmaceutical Benefits Scheme (PBS) and Repatriation Pharmaceutical Benefits Scheme (RPBS) claims history

Descriptive statistics were used to provide information on the prevalence and severity of key outcomes. Group comparisons were explored using tests of significance such as chi-squared, t-tests, standard mortality ratios (SMR), standard incidence ratios (SIR), risk ratios (RR), ratio of means, mean/median difference or hazard ratios (HR). Throughout the results, and unless otherwise specified, statistical adjustment was made for age, rank category and service branch, each estimated at August 1990 which was the approximate commencement of the Gulf War.

4 Recruitment

Recruitment for the follow up health survey commenced in October 2011 and closed in August 2012. The cohort eligible for inclusion comprised the 1,456 Gulf War veterans and 1,588 comparison group members who participated in the baseline health study. After removal of subjects identified as deceased, to have previously refused further research, or because no valid mailing address could be found, the recruitment denominators were 1,330 for the Gulf War veterans and 1,449 for the comparison group. Of those, 715 (54%) Gulf War veterans and 675 (47%) comparison group members participated. Participation rates in the four study components were high; all but four participants completed the health questionnaire, 92% completed the telephone interview, 83% consented to Medicare linkage and 77% consented to DVA health data linkage.

Men represented 98% of all participants in both study groups. Because of the small numbers of participating women and the fact that health patterns in men and women can be quite different, the results presented for health outcomes throughout the report were limited to male participants. Male participants ranged from 38 to 72 years of age. With an average age of 49 years, Gulf War veterans were slightly younger than the comparison group which averaged 51 years. More than 80% of all participants were married or in a defacto relationship, approximately 50% had a trade certificate or diploma, and about 75% earned a wage or salary as their main source of income. More than 6% of Gulf War veterans and less than 3% of the comparison group reported that their main source of income was a pension or other type of income support from the DVA. Gulf War veterans averaged 20 years of regular ADF service at follow up, whilst the comparison group averaged 21 years. 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. They were also equally likely to have deployed for at least one month on a major ADF Operation since the baseline study, and to have served in a combat role in that time.

5 Health Study Findings

5.1 Symptoms

At both baseline and follow up, participants completed the same 63-item past-month symptom checklist. At follow up the Gulf War veterans endorsed 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, as shown in Figure 1, and for 47 of those the increase was statistically significant. The greatest increases in risk were for forgetfulness, avoiding doing things, loss of concentration, feeling distant or cut off, rash or skin irritation, distressing dreams, night sweats, stomach cramps, increased sensitivity to light, feeling disoriented and skin ulcers, where the lower values of the 95% CIs indicated an increased risk of at least 25%. Many of the above-listed symptoms could be broadly categorised as neuropsychological. The most prevalent symptoms in both groups were typically neuropsychological or musculoskeletal, including feeling unrefreshed after sleep, fatigue, sleeping difficulties, muscle aches or pains, headaches, low back pain and irritability or outbursts of anger, stiffness in several joints, and ringing ears, all reported by more than 50% of the Gulf War veterans.

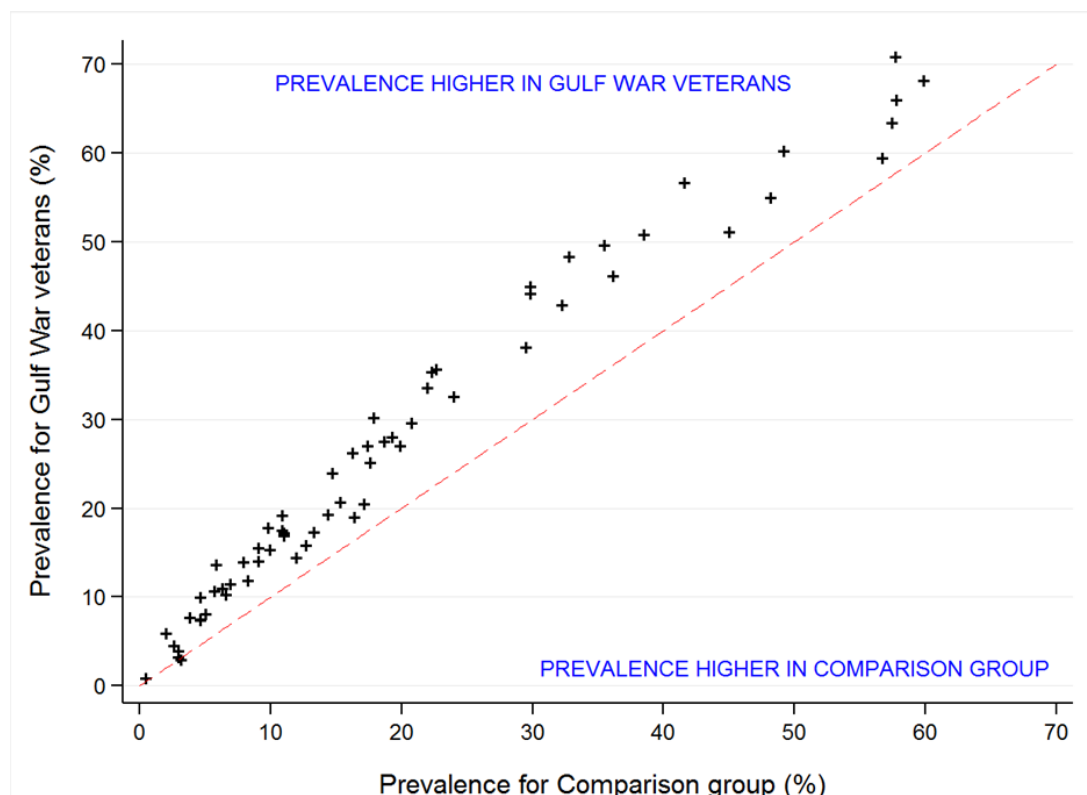


Figure 1 Past month-symptom prevalence at follow up for each of 63 symptoms

These findings were consistent with those at baseline, when Gulf War veterans reported all 63 general health symptoms more frequently than the comparison group, and the increase was significant for 56 of those. The greatest increases in risk at baseline were for neuropsychological-type symptoms. Eight of the ten symptoms most prevalent for Gulf War veterans at baseline were amongst the ten symptoms most prevalent at follow up, and these were typically neuropsychological or musculoskeletal. Symptoms which were not significantly in excess at baseline were also not significantly in excess at follow up; they were low back pain, persistent cough, toothache, tender/swollen lymph glands, vomiting, unintended weight loss and seizures.

Since baseline the mean number of past-month symptoms increased by approximately three in the veteran group and 1.5 in the comparison group. In the veteran group, about half of the symptoms were significantly more prevalent at follow up compared to baseline, whilst in the comparison group this was true for about one third of the symptoms. Amongst the 20 symptoms most prevalent at follow up, half were significantly more persistent and more incident at follow up in the veteran group, but none were significantly more persistent or incident in the comparison group.

Whilst the Gulf War veterans continued to report 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. 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.

Somatic psychological disorders can be associated with increased physical symptom reporting with no organic basis. However, CIDI-defined somatic disorders were detected in less than 2% of all participants at follow up, somatization was detected in only one participant and a somatic symptom attribution style was predominant in only 7% of all participants. Therefore somatic psychological disorders were not considered an explanation for excess symptom reporting in the Gulf War veteran group.

5.2 Multisymptom illness

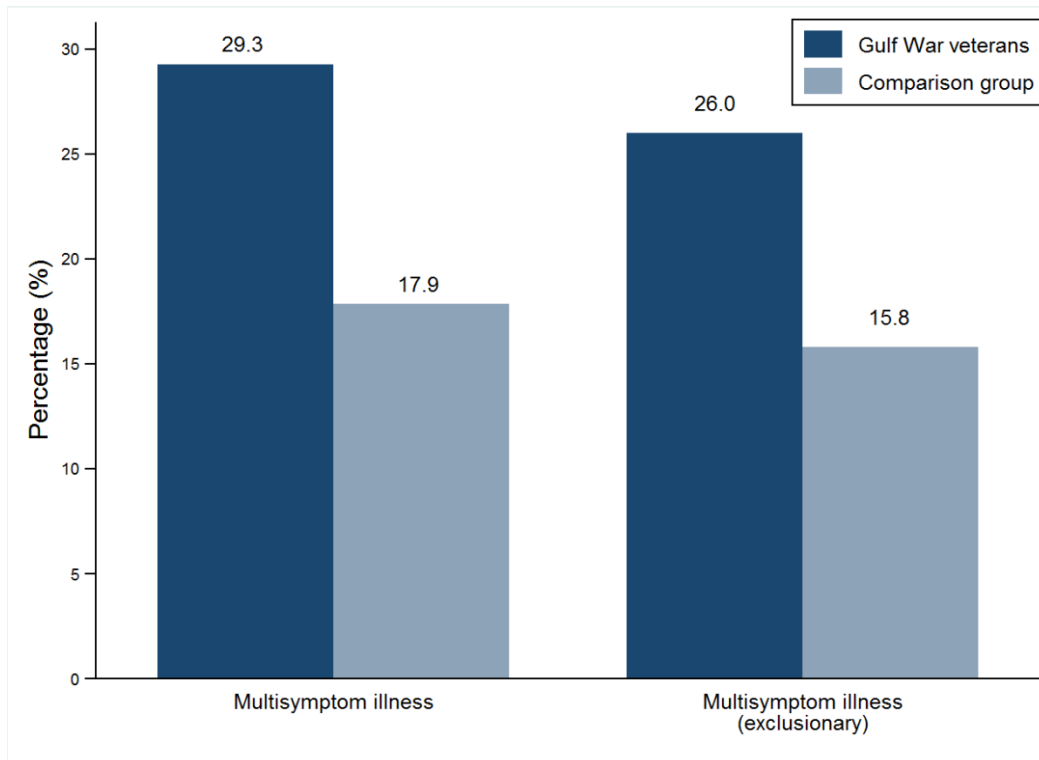


Figure 2 Percentage of participants who met criteria for multisymptom illness or multisymptom illness-exclusionary at follow up

To meet criteria for multisymptom illness, participants were required to report one or more symptoms in the past month, rated as at least moderate in severity, from at least three of four categories (fatigue, psycho-physiological, cognitive, and arthro-neuromuscular), where the latter three categories comprised the three factors identified in the exploratory factor analysis of symptoms in the baseline study.¹² An alternative set of criteria for multisymptom illness (multisymptom illness exclusionary) excluded participants with serious medical or psychiatric conditions that might explain their symptom reporting. Using both criteria, Gulf War veterans were 60% more likely than the comparison group to have multisymptom illness at follow up (multisymptom illness adj RR 1.60 95% CI 1.31-1.95; multisymptom illness exclusionary adj RR 1.60 95% CI 1.26-2.03).

As shown in Figure 2, the prevalence of multisymptom illness in Australian Gulf War veterans at follow up ranged from 26 to 29% depending upon the criteria applied, and this was consistent with US studies reporting that as many as one quarter of Gulf War veterans were suffering from an array of symptoms that, taken together, have been called multisymptom illness, Gulf War illness or Gulf War syndrome.¹³ Blanchard *et al* (2006)¹⁴ reported chronic multisymptom illness, present for at least six months, in 29% of US Gulf

War veterans ten years after deployment, and Unwin *et al* (1999)⁷ reported multisymptom syndrome based on severe symptoms only in 25% of a British Gulf War cohort.

In the ten year period since the baseline study, multisymptom illness in Australian Gulf War veterans has been very slightly more persistent, less remittent and more incident, than in the comparison group. However, the overall excess in risk of multisymptom illness of 60% in Gulf War veterans at follow up, was slightly smaller than the excess risk of 80% observed at baseline.

The finding of a persisting excess of multisymptom illness in the Australian Gulf War veteran group provides further support for the US Institute of Medicine's 2010 judgement that the weight of the scientific studies provides "*sufficient evidence of an association*" between deployment to the Gulf War and multisymptom illness.¹¹

5.3 Fatigue and chronic fatigue

In the follow up study questionnaire, participants were asked whether they had experienced extreme tiredness or fatigue following normal activities in the previous 12 months, prolonged fatigue (extreme tiredness or fatigue of at least one month's duration) in the previous 12 months, and chronic fatigue (extreme tiredness or fatigue of at least six month's duration) in the previous 12 months. These questions comprised a subset of a larger structured questionnaire administered by the assessing doctor in the baseline study medical assessment.

Twenty years after the Gulf War, extreme tiredness or fatigue following normal activities, prolonged fatigue of at least one month and chronic fatigue of at least six months were present in 33%, 17% and 12% of Australian Gulf War veterans respectively (see Figure 3). 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% (adj RR range 1.37-1.41, 95% CI range 1.02-1.96). These represented a narrowing of the magnitude of the excesses in Gulf War veterans which were observed at baseline (70%, 80% and 90% for the three outcomes respectively). In both groups, prevalence of these fatigue outcomes roughly doubled from baseline to follow up, and there were no significant differences in persistence or incidence. Using the Chalder Fatigue Scale,¹⁵ fatigue caseness (CFQ) at follow up was found in 33% of Gulf War veterans and this represented a significantly increased risk of 23% relative to the comparison group (adj RR 1.23, 95% CI 1.04-1.45), however the two groups reported similar severity of fatigue symptoms.

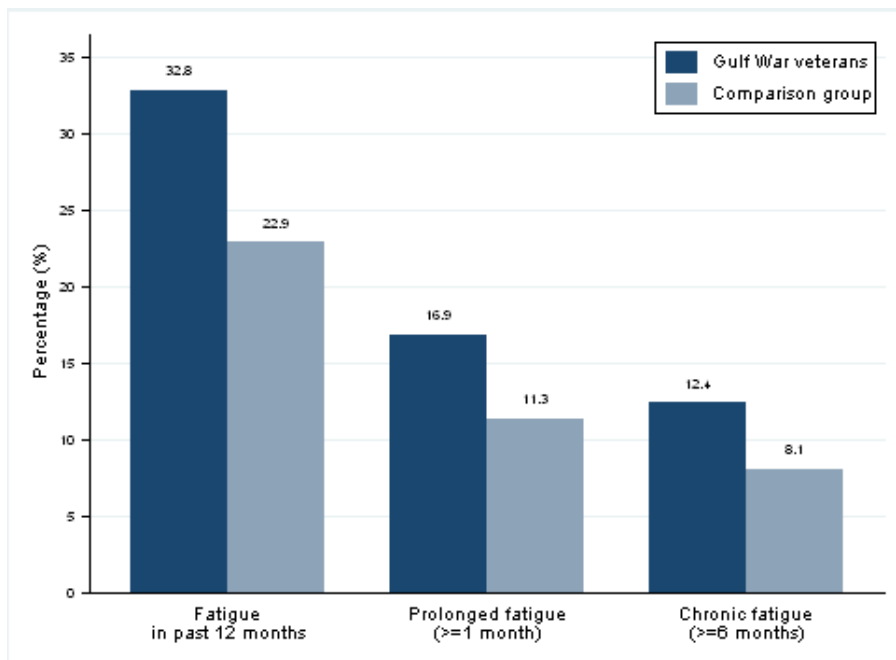


Figure 3 Percentage of participants who reported extreme tiredness or fatigue, prolonged fatigue (at least 1 month duration) or chronic fatigue (at least 6 months duration) in past 12 months

The measure of chronic fatigue of at least six months duration, in this follow up study, should not be mistaken for Chronic Fatigue Syndrome; the latter requiring a medical examination, laboratory testing and medical history. At baseline, less than 1% of Australian Gulf War veterans met criteria for Chronic Fatigue Syndrome, however that outcome could not be measured at follow up because medical examinations and laboratory testing were not conducted. Comparison of our follow up study fatigue-related findings with recent international Gulf War veteran literature was limited, both because there were few follow up studies of Gulf War veterans and because definitions used for fatigue-related outcomes vary. Based on data collected approximately 14 years after deployment, Kang *et al* (2009) reported that 9% of US veterans had “chronic fatigue syndrome-like” illness in the previous 12 months.¹⁶ Similar to our study, that outcome had almost doubled in prevalence since an assessment ten years earlier. Approximately ten years after deployment, Hotopf *et al* (2003) observed that 43% of British Gulf War veterans met CFQ criteria for fatigue. In that study, the prevalence in the Gulf War veteran group had actually decreased by 5% since an assessment four years earlier.

Consistent with the Australian Gulf War Veterans’ Follow Up Health Study, and regardless of the method of assessment, the above and other studies typically show an excess of fatigue-related outcomes in Gulf War veterans relative to comparators.^{8; 17-20} Whilst our health study did not measure Chronic Fatigue Syndrome *per se*, it provides some support for the US

Institute of Medicine's 2010 judgement that the weight of the scientific studies provides "sufficient evidence of an association" between deployment to the Gulf War and Chronic Fatigue Syndrome.¹¹

5.4 Irritable bowel syndrome and other gastrointestinal disorders

Thirteen percent of Gulf War veterans and 8% of the comparison group reported the recurrent or prolonged clusters of symptoms that meet Rome III diagnostic criteria for irritable bowel syndrome (IBS), representing an increased risk in the Gulf War veteran group of 64% (adj RR 1.64, 95% CI 1.18-2.27). The excess risk was maintained when additional analysis excluded participants who reported that they had colitis or Crohn's disease, which might have explained IBS symptoms. Rome III criteria for IBS were not applied in the baseline study and therefore change over time could not be investigated.

Interestingly, less than 1% of all participants reported that a medical doctor had diagnosed them with, or treated them for, IBS. That could indicate that study participants have not been reporting symptoms of IBS to doctors, or that doctors have not been diagnosing IBS as the condition underlying the reported symptoms. However, the same theory could be applied to the self-report of colitis or Crohn's disease, which could be under-estimated in the follow up study and which could explain more IBS symptoms than we have estimated. A comprehensive medical examination and medical history would, of course, provide a more robust estimate of the true IBS prevalence in the study groups, however the Rome III criteria are considered valid and reliable.^{21; 22}

Information about gastrointestinal disorders other than IBS at follow up, were collected by self-reported doctor-diagnosis or treatment only. Prevalences were low, for example, 5% of Gulf War veterans reported stomach or duodenal ulcers, 2% reported reflux related diseases, hernia or oesophagitis, less than 1% reported diverticular disease and less than 0.5% reported coeliac disease. The prevalences of these disorders were not significantly different between the two study groups, although peptic ulceration was the most suggestive of an excess in Gulf War veterans. Self-reported past month symptoms of gastrointestinal type, however, including indigestion, diarrhoea and stomach cramps were significantly more prevalent in the veteran group.

The US IOM reviewed a number of Gulf War studies that reported excess gastrointestinal complaints in Gulf War veterans.¹¹ In a sample of only 247 Gulf War veterans registered at

Veterans' Affairs Medical Centers, Tuteja *et al* (2008)²³ reported that 0.4% met Rome III IBS criteria pre-deployment, 17% met criteria during deployment and 40% met criteria post deployment. These findings, however, were severely limited, not only by the small sample size and selection from medical centres, but also by the fact that participants were surveyed only once and required to retrospectively recall their bowel habits for the pre- and during-deployment measures. Ten years after deployment, Eisen *et al* (2005)²⁴ reported increased odds of dyspepsia of 87%, and increased odds of gastritis of 57% in US Gulf War veterans. Gray *et al* (2002) reported the odds of self-reported physician-diagnosed IBS in Gulf War deployed Seabees (a US Navy Construction battalion) to be more than three times the odds in non-deployed Seabees. Two physiological studies of symptomatic Gulf War veterans demonstrated chronic inflammation consistent with postinfectious IBS.^{25; 26} Numerous studies reported excess gastrointestinal symptoms, such as gas and cramps,^{27; 28} bloating,²⁷ and diarrhoea.²⁷⁻³⁰

The IOM¹¹ reports that the most compelling evidence for an association between Gulf War deployment-related exposures and IBS, is that in relation to exposure to enteric pathogens during deployment leading to the development of postinfectious IBS.^{25; 31} The Australian Gulf War Veterans Follow Up Health Study exposure analyses (described later in section 6) showed an elevated risk, but not significantly so, of IBS in Gulf War veterans rated as having 'possible exposure' to gastroenteritis outbreaks. That exposure rating, however, was based on deployment with a Ship or group for which records reported outbreaks of gastroenteritis. The magnitude or severity of the outbreaks, however, could not reliably be estimated, nor could any individual's level of exposure.

Overall, the Australian Gulf War Veterans Follow Up Health Study findings are consistent with the IOM's 2010 judgement that the weight of the scientific studies provides "*sufficient evidence of an association*" between deployment to the Gulf War and functional gastrointestinal disorders such as irritable bowel syndrome, but "*inadequate/insufficient evidence of an association*" between deployment to the Gulf War and structural gastrointestinal disorders such as ulcers and Crohn's disease or colitis.¹¹

5.5 Musculoskeletal disorders

The follow up study showed 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. Osteoarthritis of the hip was significantly less prevalent in the Gulf War veterans (9%) than in the comparison group (19%).

At baseline, 5% of participants in both study groups self-reported doctor diagnosed or treated, "arthritis or rheumatism". Other studies at around that time, also relying on self-reported prevalence of arthritis, showed significant excesses in Gulf War veterans.^{32; 33} Additional studies reporting musculoskeletal diseases have primarily relied on hospitalisation studies using discharge diagnosis data.³⁴⁻³⁶ The results of these studies were mixed and were limited by the restriction to musculoskeletal diseases resulting in hospitalisation (arthritis, for example, would not typically require hospitalisation), and a lack of outpatient data.

The follow up study results provide further support for the IOM's 2010 judgement that the weight of the scientific studies provides "*inadequate/insufficient evidence of an association*" between deployment to the Gulf War and musculoskeletal disorders.¹¹

5.6 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 on Von Korff's (1992)³⁷ Chronic Pain Grade scale. Approximately two in five participants reported that pain had kept them from their usual activities for one or more days in the previous six months. There were no significant differences, however, in the overall pain grade ratings.

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 (adj RR 1.47 95% CI 1.12-1.93), and more than two and half times more likely to report 11 or more body areas of pain or tenderness (adj RR 2.89 95% CI 1.01-8.28). Several pain-related past month symptoms were reported more frequently by Gulf War veterans; including headaches, pain without swelling or redness in several joints, itchy or painful eyes and stomach cramps. The most frequently reported pain-related health symptoms in the past month, for both study groups, were general muscle aches or pains, headaches and low back pain; each reported by more than half of all participants.

A severe manifestation of chronic widespread pain is fibromyalgia, characterised by widespread muscle and skeletal pain in combination with point tenderness at numerous soft tissue sites.³⁸ Diagnosis is dependent on clinical examination and therefore fibromyalgia was not assessed in the follow up study other than by self-reported doctor-diagnosis. It was reported by only two participants in each study group.

International Gulf War veteran studies reporting pain-related outcomes have employed various methods and definitions. Stimpson *et al* (2006) reported a significant excess in chronic widespread pain in Gulf War veterans (17%) relative to era comparators (8.5%) based on self-reported data on paper pain manikins.³⁹ Forman-Hoffman *et al* (2007) found that the odds of Gulf War veterans reporting symptoms of chronic widespread pain was twice that of non-deployed comparators, based on participants reporting fibromyalgia or fibrositis, or overall body pain every day for at least three months, and body pain in the 24 hours before interview.⁴⁰ In general, many Gulf War veteran studies report increased pain symptoms in Gulf War veterans.⁴¹

The Australian Gulf War Veterans' Follow Up Health Study finding of increased number of pain sites and increased pain related symptoms in Australian Gulf War veterans, but not increased pain grade, provides limited support to the IOM's 2010 judgement that the weight of the scientific studies provides "*limited but suggestive evidence of an association*" between deployment to the Gulf War and chronic widespread pain.¹¹ However these follow up study findings do not provide sufficient evidence to assess the IOM's 2010 judgement that there is "*limited but suggestive evidence of an association*" between deployment to the Gulf War and fibromyalgia.¹¹

5.7 Reproductive outcomes

It is of major concern to Gulf War veterans that their deployment may have adversely impacted upon their reproductive and sexual functioning in the post-deployment period. The Australian Gulf War Veterans' Follow Up Health Study found that Gulf War veterans were statistically significantly more likely than the comparison group to report difficulty fathering a pregnancy since January 1992 (13% vs 8%; adj RR 1.44, 95% CI 1.05-1.99). Of those who reported difficulty fathering a pregnancy, Gulf War veterans were significantly less likely than the comparison group to report that a cause for their infertility had been found (24% vs 41%, adj RR 0.55, 95% CI 0.34-0.87) but equally likely to have sought or undertaken infertility treatment, and equally likely to have fathered a pregnancy.

About one half of all participants fathered a pregnancy in the period since 1992 and, of those, the average number of pregnancies per participant was about two. Approximately 80% of pregnancies were reported to have resulted in a live birth, approximately 15% resulted in a miscarriage, less than 1% resulted in a stillbirth and 4% were terminated. About 87% of live birth babies were full-term and normal birth weight. There were no differences between the two groups on these reproductive health measures.

Since the baseline study a larger proportion of Gulf War veterans than comparison group participants reported doctor-diagnosed or treated impotence (8.5% vs 4.5%, adj RR 2.06, 95% CI 1.30-3.29). Also, in the month prior to the follow up study, Gulf War veterans were more likely than the comparison group to report problems with sexual functioning (32% vs 24%, adj RR 1.39, 95% CI 1.17-1.65) and loss of interest in sex (43% vs 32%, adj RR 1.34 (1.16-1.54).

In summary, Gulf War veterans were more likely than comparison group participants to report difficulty with fertility and sexual functioning however, despite this, the two groups were equally likely to father a pregnancy which resulted in the live birth of a full-term baby with normal birth weight. This was similar to the pattern of findings observed at baseline.

The findings of the Australian Gulf War Veterans' Follow Up Health Study, and studies of international Gulf War veterans, are consistent with the IOM's 2010 judgement that there is *"inadequate/insufficient evidence of an association"* between deployment to the Gulf War and fertility, and pregnancy outcomes such as miscarriage, stillbirth, preterm birth, and low birth weight, but *"limited/suggestive evidence of an increased prevalence of self-reported sexual functioning difficulties among Gulf War veterans"*.

5.8 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. For example, 27% of Gulf War veterans versus 16% of the comparison group reported moderate to severe or very severe difficulty falling asleep; the difference for moderate to severe or very severe difficulty staying asleep was 37% vs 29% and the difference for moderate to severe or very severe difficulty waking up early was 29% vs 20%. Overall levels of daytime sleepiness were similar between the two groups. However, twice as many Gulf War veterans as comparison group participants (5% vs 2.4%) achieved a daytime sleepiness score greater than 16, which Johns (1991)⁴² observed only in patients with narcolepsy, idiopathic

hypersomnia or moderately severe obstructive sleep apnoea. Approximately 10% of participants in both groups reported doctor diagnosed, or treated, sleep apnoea, and this was roughly triple the prevalence reported at baseline. Other than sleep apnoea, sleeping pattern and daytime sleepiness were not investigated at baseline and so changes in these over time could not be assessed.

We found no recent studies of the prevalence of sleep disturbance in Gulf War veterans. We identified one recent study of cholinergic autonomic deficits in symptomatic Gulf War veterans where sleep dysfunction was identified as an autonomic symptom.⁴³ Data collected by Proctor *et al* (1998) two years after the Gulf War deployment, showed 'unsatisfactory sleep' to be among the three most prevalent symptoms in Gulf War veterans from Fort Devons in the US.⁴⁴ Also, the odds of 'inability to fall asleep' was about 3½ times higher in Gulf War veterans (30%) relative to comparators (11%).⁴⁴ Approximately nine years after the Gulf War, Ismail *et al* (2002)⁴⁵ investigated Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (DSM IV) sleep disorder but only in a very small sample of British Gulf War veterans who had previously reported impaired physical function (n=111) compared with Bosnia and era veterans who had also previously reported impaired physical function (n=133). DSM IV sleep disorder was present in 18% and 14% respectively, which suggested that sleep disorder was not unique to impaired veterans of the Gulf War.

The IOM have not investigated sleep disturbance as an outcome of Gulf War deployment. Our findings support a strong association between Gulf War deployment and difficulty falling asleep, staying asleep and, to a lesser extent, staying awake. There is also an indication that Gulf War deployment is associated with severe daytime sleepiness.

5.9 Respiratory health

Respiratory health was assessed at both baseline and follow up, however differences between the two studies in regard to the scope and mode of data collection limited our ability to assess change over time. At follow up, a brief list of respiratory symptoms and medical conditions were assessed via self-report questionnaire using a set of questions pared down or modified from the larger set administered by a nurse in the baseline study. The baseline study also included lung function testing using a spirometer, which was not included at follow up. The follow up study included an assessment of respiratory health medications dispensed to participants under the PBS or RPBS, which was not included at baseline.

At follow up, respiratory symptoms in relation to wheeze, cough and sputum were all 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% (95% CI 1.26-2.23), followed by 44% for wheeze (95% CI 1.15-1.80), 38% for morning sputum in winter (95% CI 1.10-1.74) and about 36% for day or night time cough including being woken by cough (95% CI 1.09-1.70). 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 (COPD) were all reported more frequently by Gulf War veterans. These findings were consistent with those observed at baseline, except for self-reported doctor-confirmed chronic bronchitis which was significantly in excess at baseline. PBS and RPBS data did not show a significant difference between the two groups in regard to respiratory medication use in the 12 months prior to follow up, although it is acknowledged that many asthma medications can be bought over the counter.

The overall levels of self-reported doctor-confirmed asthma were slightly higher in the study participants (13% for Gulf War veterans and 11% for the comparison group) relative to the 9% estimated for the Australian male population in the 2007-2008 National Health Survey data.⁴⁶ However this difference was not tested statistically, and may not be evident once confounders such as age, smoking and socio-economic indices are taken into consideration.

Consistent with our findings at follow up, international Gulf War veterans' studies have often shown excesses of self-reported respiratory symptoms, and self-reported diagnoses of respiratory conditions in Gulf War veterans relative to comparators. For example, the Iow Persian Gulf Study Group reported the prevalence rate for symptoms of both asthma and bronchitis to be 2.3% higher in Gulf War veterans relative to non-Gulf War comparators;⁶ and Unwin *et al* (1999) found the odds of a self-reported diagnosis of bronchitis to be between 40-70% higher in British Gulf War veterans relative to Bosnia and era comparators.⁷ Our finding at follow up of no difference between groups for recent respiratory medication use, is also consistent with other studies which have shown no differences on objective markers of respiratory health including spirometry,^{47; 48} diagnosis category upon hospitalisation³⁵ or respiratory disease mortality rates.⁴⁹

Overall, the Australian Gulf War Veterans' Follow Up Health Study findings are consistent with the IOM's 2010 judgement that there is "*inadequate/insufficient evidence of an association*" between deployment to the Gulf War and respiratory disease.¹¹

5.10 Neuropathic symptoms

Participants in both study groups averaged only two of the 17 symptoms measured. Gulf War veterans were significantly more likely than the comparison group, however, to report at least one neuropathic symptom (60% vs 52%, adj RR 1.13, 95% CI 1.03-1.25), or at least four neuropathic symptoms (24% vs 18%, adj RR 1.32, 95% CI 1.07-1.64), one or more symptom of muscle weakness (44% vs 36%, adj RR 1.23, 95% CI 1.08-1.41) and one or more symptom of sensory disturbance (45% vs 39%, adj RR 1.14, 95% CI 1.00-1.29). Individual symptoms which were reported significantly more frequently by Gulf War veterans were 'difficulty lifting objects above the head', 'difficulty getting up from sitting in a chair', 'problems with feet tripping or feet slapping when walking', 'difficulty feeling pain cuts or injuries' and 'unusual sensitivity or tenderness of your skin when rubbed by clothes or bedclothes'.

Neurological diseases including epilepsy, multiple sclerosis and motor neurone disease were each reported as doctor-diagnosed or treated since January 2001 by only four or fewer participants in total. These results were almost unchanged from the baseline results.

Relative to the baseline study, the gap between groups in the proportions of participants with neuropathic symptoms has narrowed. At baseline, Gulf War veterans were significantly more likely to report 16 of the 17 symptoms measured, whereas this difference was significant for only five of 17 symptoms at follow up.

The baseline study included a face-to-face neurological examination from which a neuropathy impairment score and other neuropathic health outcomes were derived, however that examination was not repeated at follow up.

Our findings provide some limited support to the IOM's 2010 conclusions that there is "*limited/suggestive evidence of an association between deployment to the Gulf War and peripheral neuropathy.*" and "*inadequate/insufficient evidence to determine as association between deployment to the Gulf War and multiple sclerosis*".¹¹

5.11 Self-assessed physical health status

Given the above-listed excesses in adverse health outcomes in Australian Gulf War veterans, it is not unexpected that the self-reported physical health status of the Gulf War veterans was poorer than that of the comparison group, using the Short Form -12 Health Survey

Physical Component Summary score (SF12-PCS).⁵⁰ The differences between the two groups were greatest for the participants who were oldest and lowest ranked at the time of the Gulf War. In both study groups, self-perceived physical health status declined in the ten year period from baseline to follow up. That pattern was consistent with population studies that show health status to decline with age.⁵¹ Whilst there was no significant difference between the two groups in regard to the magnitude of the decline in self-reported physical health status over time, the gap between the two groups at follow up (SF12-PCS mean diff - 1.5) was very slightly wider than that at baseline (SF12-PCS mean diff -0.7).

5.12 Posttraumatic stress disorder

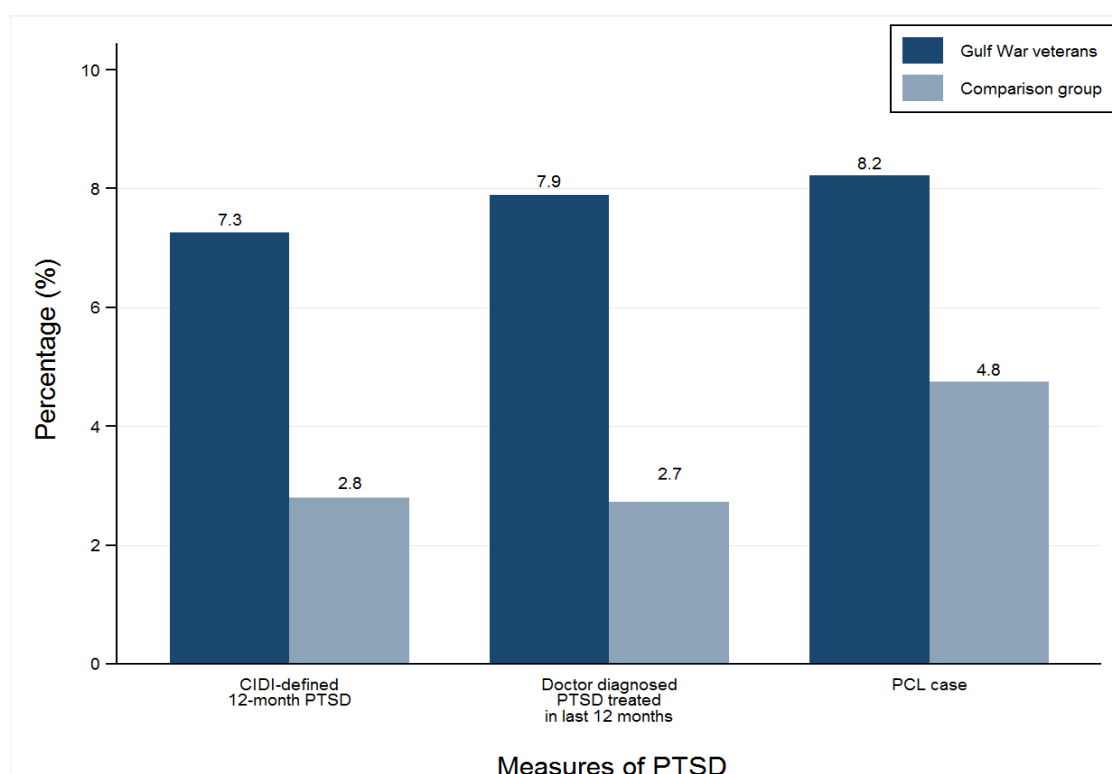


Figure 4 Percentage of participants who had PTSD based on the CIDI interview, the Posttraumatic Stress Disorder Check List (PCL) and self-reported doctor diagnosed and treated PTSD in the past 12 months

Using three different measures, the risks of PTSD at follow up in Australian veterans of the Gulf War were between 1½ and three times greater than the risks in the comparison group (see Figure 4). Approximately 8% of Gulf War veterans met criteria for PTSD relative to about 3% to 5% of the comparison group. In the decade or so since baseline the risk of CIDI-defined 12 month PTSD had almost doubled in the Gulf War veteran group (RR 1.96 95% CI 1.29-2.97), whilst in the comparison group the smaller increase was not statistically significant (RR 1.50 95% CI 0.72-3.12). Since the baseline study, new (incident) cases of

PTSD have been more likely to occur in Gulf War veterans than in the comparison group (adj RR for incidence 2.29 95% CI 1.24-4.24). 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 has, therefore, widened since baseline.

We only identified two other studies that had measured PTSD longitudinally in a representative sample of Gulf War veterans. Similar to our study, but at approximately 14 years after deployment, Kang *et al* (2009) demonstrated a three-fold excess in the risk of PCL-derived PTSD in US Gulf War veterans relative to era comparators.⁵² Using the same dataset, Li *et al* (2011) showed that the prevalence of PTSD had increased in the Gulf War veteran group since baseline ten years earlier, but remained stable among comparators, and that PTSD had been more persistent and incident in the Gulf War veteran group.⁵³

Many older studies have consistently demonstrated increased risk of PTSD in Gulf War veterans. For example, approximately ten years after the Gulf War deployment, Fiedler *et al* (2006) reported CIDI Short Form 12 month PTSD to be evident in 3.4% of US Gulf War veterans compared to 0.7% in non-deployed controls.⁵⁴ Goss Gilroy Inc (1998) reported the odds of PCL-derived PTSD in Canadian veterans of the Gulf War to be 2.7 times the odds in non-deployed veterans.⁸ Brailey *et al* (1998) assessed US Gulf War veterans at 9 months post-deployment and again 16 months later, and showed PTSD rates to be increasing over time and correlated with war-zone stress and high-risk activities.⁵⁵

Based on the weight of the evidence up to the end of 2008, the IOM concluded that there was *“sufficient evidence of a causal association between traumatic war exposures experienced during deployment to the Gulf War and PTSD”*. Our findings provide further support for that conclusion and, in addition, support for the persistence of excess PTSD more than 20 years after the War. In fact, the magnitude of the excess in risk for PTSD in Australian Gulf War veterans was larger than the excess risk observed for other health outcomes included in this follow up study. In conclusion, 20 years after the Gulf War PTSD rates remain at elevated levels and the prevalence of PTSD in the veteran group appears to be increasing, rather than decreasing.

5.13 Alcohol disorder

The percentage of participants estimated to have alcohol disorder at follow up was highly variable across three measures used. As shown in Figure 5, 6% of Gulf War veterans met

CIDI criteria for 12 month alcohol disorder, 29% met Alcohol Use Disorders Identification Test (AUDIT) criteria for alcohol disorder in the past 12 months, but only 3% reported doctor-diagnosed alcohol disorder treated in the previous 12 months. The risk of alcohol disorder at follow up was estimated to be 1¼ to two times higher in the veteran group relative to the comparison group, and this was significant for the CIDI (adj RR = 1.93 95% CI 1.10 – 3.38) and AUDIT results (adj RR = 1.26, 95% CI 1.05 – 1.52), but not for self-reported doctor diagnosis and treatment (adj RR = 1.55, 95% CI 0.64 – 2.81). Very few participants met criteria for 12 month substance disorders other than alcohol, and therefore no conclusions about other substance disorders could be made.

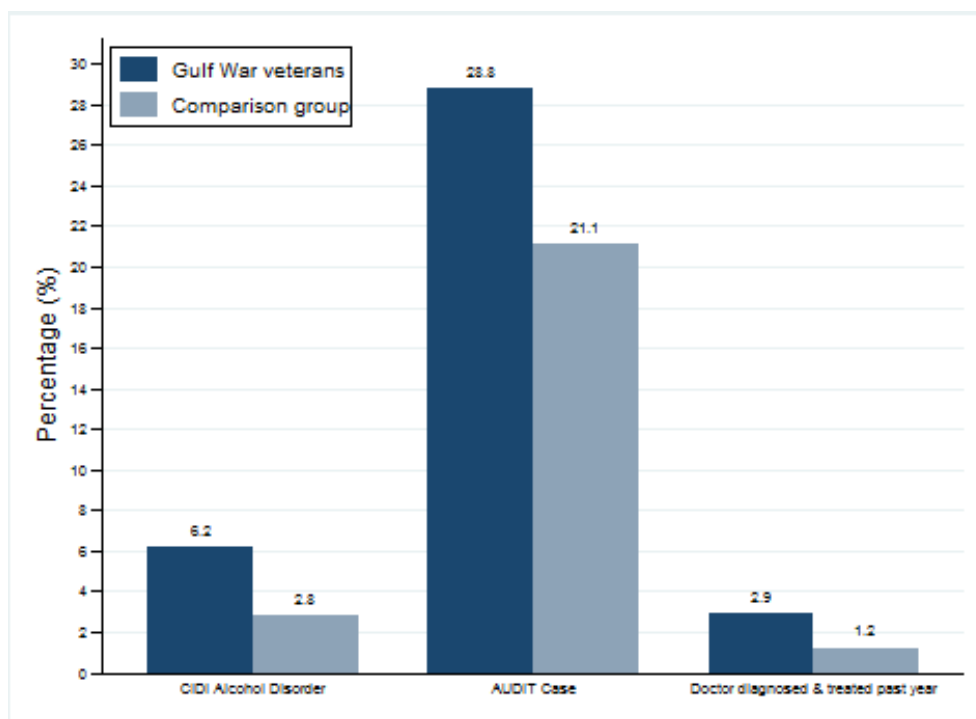


Figure 5 Percentage of participants with possible alcohol disorder in the past 12 months based on CIDI, AUDIT and self-report doctor-diagnosis data

The AUDIT is a self-report screening instrument for harmful or hazardous levels of drinking or drinking-related behaviour, rather than an actual diagnosis, and so prevalence might be expected to be higher for this measure rather than for the more comprehensive CIDI DSM IV diagnosis of alcohol disorders. The very low prevalence of doctor diagnosed and treated alcohol disorder suggests the possibility that participants have been under-reporting diagnoses of alcohol disorder, or not reporting alcohol symptoms to medical doctors in the first place, or that medical doctors have not been identifying alcohol disorder as the condition underlying the reported symptoms.

Based on the CIDI data, risk of 12 month alcohol disorder in Gulf War veterans had approximately doubled in the ten 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. Whilst, proportionately, 12 month alcohol disorder in Gulf War veterans has been slightly more persistent, slightly less likely to remit and new cases have been slightly more likely to occur relative to the comparison group, these differences were also not statistically significant. Nonetheless, the gap between the two groups in alcohol-related morbidity is gradually widening over time.

At 14 years post-deployment, Kang *et al* (2009) demonstrated a 24% excess in the risk of probable 6 month alcohol abuse (based on the PHQ alcohol module)⁵⁶ in US Gulf War veterans relative to era comparators.⁵² At ten years post-deployment, Fiedler *et al* (2006) reported CIDI Short Form 12 month alcohol dependence to be evident in about 5% of US Gulf War veterans compared to 3.3% in non-deployed controls, but this difference was not significant.

This Australian Gulf War Veterans' Follow Up Health Study provides further support for the US Institute of Medicine's 2010 judgement that the weight of the scientific studies provides "*sufficient evidence of an association between deployment to the Gulf War and substance abuse particularly alcohol abuse... [and] these disorders persist for at least 10 years after deployment*".¹¹ In our results, it is of concern that the prevalence of alcohol-related morbidity is increasing in both study groups, and the gap between the Gulf War veterans and comparison group is gradually widening. On a more positive note, the Australian Gulf War Veterans' Follow Up Health Study does not provide evidence of high levels of substance abuse other than alcohol in the two study groups.

5.14 Major depression

More than 20 years after the Gulf War, the rate of CIDI-defined 12 month major depression was similar in the two study groups, observed in almost 10% of Australian Gulf War veterans and almost 8% of the comparison group. Importantly, this indicated that the vast majority of study participants did not have major depression. At the time of the baseline study, the Gulf War veterans were found to be significantly more likely than the comparison group to have CIDI-defined 12 month major depression (adj OR 1.7, 95%CI 1.2 - 2.3)⁵⁷ however at follow up the prevalence gap between the two groups was no longer statistically significant (adj RR = 1.2, 95% CI 0.8 - 1.7).

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 under the PBS or RPBS in the 12 months prior to the follow up study (adj RR = 1.56, 95% CI 1.05 - 2.32). 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.

Longitudinally, there was a pattern of major depression being slightly more persistent, slightly less likely to remit and slightly more incident in Gulf War veterans relative to comparison group participants, however these differences were not statistically significant.

In a similar pattern to that which we observed 10 years ago,⁵⁸ the prevalence of 12 month major depression in Gulf War veterans at follow up was associated with higher numbers of Gulf War-related psychological stressors. Further analysis could reveal whether particular groups or types of stressors are driving the association between higher stressor score and subsequent increased depressive morbidity.

In an, as yet, unpublished systematic review and meta-analysis of 1990-2012 studies of depression in Gulf War veterans, we found that Gulf War veterans had over twice the odds of experiencing depression compared to non-deployed military personnel (OR 2.3, 95%CI 1.9-2.8). Our findings at 20 year follow up, however, indicate that the prevalence gap in major depression between Australian Gulf War veterans and comparators appears to be closing, although depressive symptoms may still be more severe in Gulf War veterans. The Australian Gulf War Veterans' Follow Up Health Study findings provide only limited support for the IOM's 2010 conclusion that there is "*sufficient evidence of an association*" between Gulf War deployment and depressive disorder.

5.15 Other psychological health indicators

Australian Gulf War veterans reported significantly poorer mental health status on the SF12 at follow up, and they were at 19% greater risk of general psychological distress (as measured by the 12-item General Health Questionnaire; GHQ-12) relative to the comparison group. Both outcomes were strongly associated with increasing number of self-reported Gulf War-related stressors. In addition, GHQ-12 psychological distress was weakly associated with younger age at deployment. Gulf War veterans also had higher levels of demoralisation, and this was demonstrated across a number of dimensions representing feelings of loss of

meaning, dysphoria and disenheartenment. 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. These findings were not unexpected considering the association between demoralisation and mental health problems, particularly depression,⁵⁹ and between suicidality and demoralisation,⁶⁰ mental health problems, particularly PTSD,⁶¹ trauma exposure⁶² and also military service in general.⁶³ However, actual suicide rates among Gulf War veterans were not elevated.

There were some more positive findings in relation to Gulf War veteran psychological health at follow up. CIDI-defined 12 month disorders other than PTSD, alcohol and major depression (all discussed above), were infrequent in both study groups and there was no evidence of any excess risk in Gulf War veterans. The most prevalent of these *other* CIDI-defined 12 month disorders at follow up was specific phobia (5% of all participants), followed by social phobia (3.6%), bipolar disorder (3.3%) and obsessive compulsive disorder (3%).

However, Gulf War veterans were significantly more likely than the comparison group to have at least one CIDI-defined 12 month disorder (25% vs 17%) when all CIDI-defined 12 month disorders were included, including PTSD, alcohol and major depression. There was no excess risk in the Gulf War veterans group of meeting screening criteria for full administration of any of the Psychosis, Intermittent Explosive Disorder or Eating Disorders modules of the CIDI.

Gulf War veterans and comparison group participants were also similar in regard to their likelihood of being *average*-, *above average*- or *severe* risk takers. Relative to the comparison group, Gulf War veterans scored slightly lower on risk-taking propensity factors labelled *self-control* and *self-confidence*, and slightly higher on the factor labelled *invincibility*. The latter difference might, to a small extent, explain the very small excess observed in Gulf War veterans in relation to falls leading to injury and injuries possibly involving concussion.

Importantly, although perhaps surprisingly, the two study groups were found to be equally resilient. This is a positive finding for the Gulf War veterans, being a measure of their ability to thrive despite adversity.

5.16 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 bad 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 marginally significant ($p=0.04$). The two study groups did not differ in regard to the activity types to which their injuries were attributed. Sport was the activity-type most frequently reported, with one third of recent injuries attributed to this. Leisure, working for an income outside of the ADF and other work were also frequently reported with more than 20% of injuries attributed to these.

Injury resulting in attendance at hospital as an inpatient, which could possibly be an indicator for the most severe injuries, was reported by slightly more Gulf War veterans (14%) than comparison group participants (9%), however this difference did not meet statistical significance ($p=0.187$). The two groups were equally likely to attend other types of health services, or to have required time off from work/study, as a result of their injury. Injuries in the previous 12 months which were sustained when respondents were under the influence of alcohol or other substances, were very infrequently reported.

Respondents were asked to report whether any injuries received in the past three years involved being dazed, confused or seeing stars; not remembering the injury; or losing consciousness (knocked out), as possible indicators of concussion. The Gulf War veterans were slightly, but statistically significantly more likely, than the comparison group, to report at least one of the three concussion-related consequences of injury (11% vs. 7%; $p=0.013$).

O'Donnell et al (2009)⁶⁴ showed that prior trauma or prior psychiatric illness may represent risk pathways to injury. The findings in this follow up study, of increased psychological morbidity in Gulf War veterans in combination with the veterans scoring slightly higher on the risk-taking factor labelled *invincibility*, may explain the slight excesses in recent fall-related injuries, injuries requiring hospitalisation and injuries possibly involving concussion in the veteran group.

5.17 Life events

Questions about traumatic life events, financial strain, homelessness and convictions or incarcerations were included in this follow up study because these outcomes could be associated with chronic health problems, social dysfunction or maladaptive behaviours related to war deployment. In combination with the spectrum of physical and psychological outcomes measured in this follow up study, the above measures facilitate a more comprehensive investigation of the full impact of Gulf War deployment on the lives of Gulf War veterans.

More than half of the participants in both study groups had experienced at least one potentially traumatic event. The pattern of exposure to potentially traumatic events was similar for the two groups, and so life experiences of this nature 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 psychological morbidity in Gulf War veterans does not appear to be resulting in increased exposure to traumatic events.

Similarly, Gulf War veterans were not more likely than the comparison group to have experienced financial difficulty which had led to events such as the inability to pay utilities, car registration or insurance on time, or the need to seek financial assistance from friends or family or welfare organisations. Events such as these were, however, reported by 17% of all participants. Very small numbers of participants reported homelessness or incarcerations and there was no difference between the study groups on these measures. Gulf War veterans were very slightly more likely than the comparison group to have received a criminal conviction in the period since August 1990. This finding could be an early sign of severe social dysfunction or maladaptive behaviours related to Gulf War deployment and possibly connected to chronic morbidity. It is known, for example, that anxiety disorders, affective disorders and alcohol disorders, all observed to be in excess in Gulf War veterans at follow up, are associated with increased risk of incarceration in the Australian population.⁶⁵ This alone is sufficient reason to assertively target mental health prevention, intervention and treatment programs to minimise these types of adverse social outcomes.

5.18 Life satisfaction and quality of life

There were no statistically significant differences between the Gulf War veterans and comparison groups at follow up on measures of life satisfaction using the Life Satisfaction Scale⁶⁶ and Overall Quality of Life and Health Satisfaction using the World Health Organization brief Quality of Life questionnaire (WHOQOL-Bref).⁶⁷ However there was a consistent pattern of Gulf War veterans tending to rate themselves a little lower on these measures. For example, when asked about their life satisfaction, that being how they felt about their life as a whole including what they expected to happen in future, Figure 6 shows that Gulf War veterans were a little less likely than the comparison group to report that they felt delighted or pleased, and a little more likely to report feeling unhappy, mostly dissatisfied, mixed or mostly satisfied.

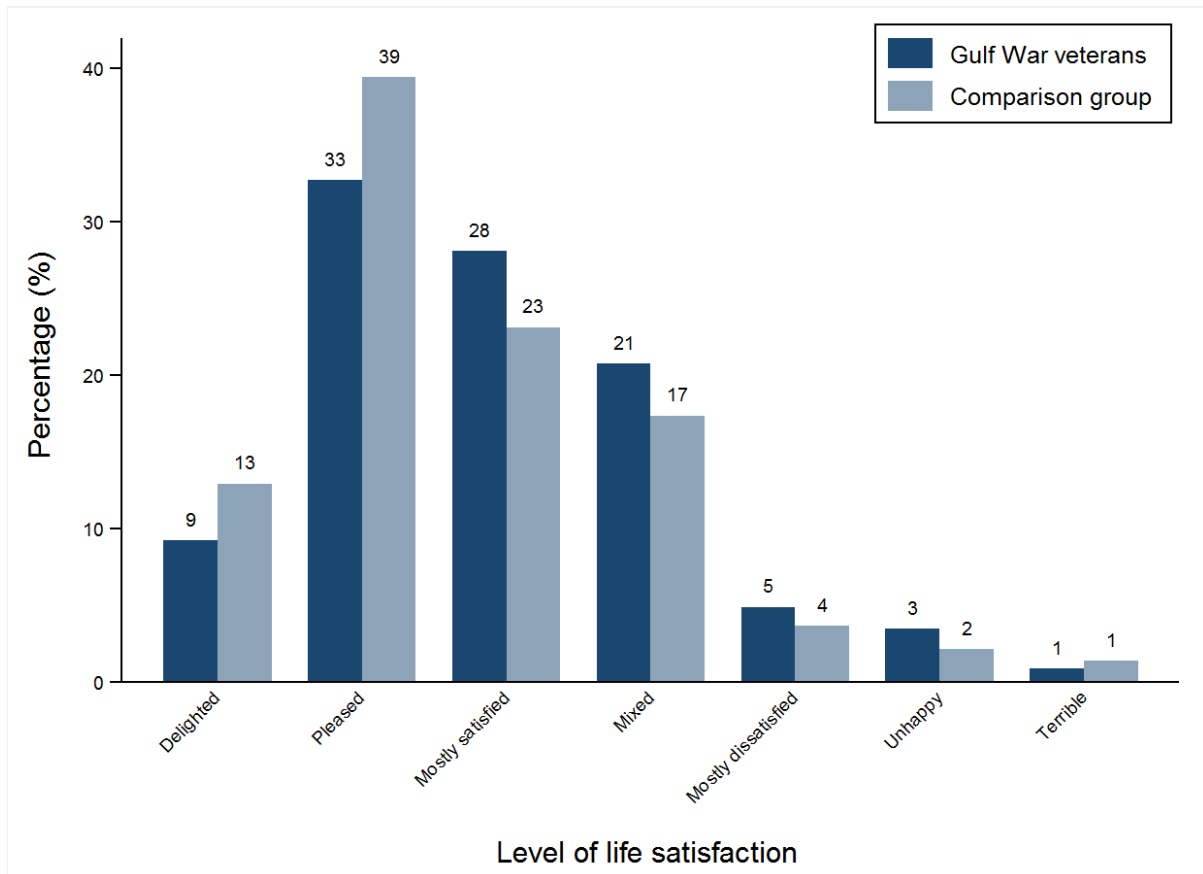


Figure 6 Distribution of Life Satisfaction Scale responses for participants at follow up

Gulf War veterans were also a little less likely than the comparison group to rate their overall quality of life, on the WHOQOL-Bref, as very good and more likely to rate their overall quality of life as very poor, poor, neither poor nor good or good. Further, Gulf War veterans were a little less likely than the comparison group to report being satisfied or very satisfied with their health, on the WHOQOL-Bref, and more likely to report being dissatisfied or neither dissatisfied nor satisfied. Some of these differences met statistical significance before, but not after, adjustment for age, service and rank, indicating that it might be those factors underling these differences between the two study groups and not Gulf War deployment.

Considering that life satisfaction, health satisfaction and overall quality of life are undoubtedly associated with physical and psychological health⁶⁸ the fact that Gulf War veterans are similar to the comparison group on these measures is an indication of their positive outlook on life despite adversity, consistent with the findings in relation to their resilience.

Other measures of WHOQOL-Bref quality of life, however, were significantly poorer in the Gulf War veteran group, and these were no doubt reflective of the adverse health outcomes which were in excess. Gulf War veterans reported significantly poorer quality of life on the

Physical Health domain of the WHOQOL-Bref which comprised items such as ability to perform activities of daily living and mobility. Gulf War veterans also reported significantly poorer quality of life on the Psychological domain comprising items such as self-esteem, concentration, negative mood and body image, and significantly poorer quality of life on 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.

Life satisfaction and quality of life were not measured at baseline and so change over time in these outcomes could not be investigated.

5.19 Social health

Social health has been described as the dimension of a person's wellbeing in regard to how that person gets along with other people, how other people react to him/her and how that person interacts with social institutions and societal codes or mores.⁶⁹ Social health was of relevance to this follow up Gulf War veterans' health study for a number of reasons including:

- i. people who are well integrated in to their communities tend to live longer, achieve greater personal growth, and have greater capacity to recover from disease and stressful events;
- ii. people with disease or disability need social support to remain in the community and live productive lives in society; and
- iii. disease or disability may precipitate fractures in social health through the limitations imposed on usual role functioning, occupation and community participation.

Social support is an aspect of social health, generally defined in terms of the availability of people whom the individual trusts, or whom he can rely on, and who makes him feel cared for and valued.⁷⁰ Although the Australian Gulf War veterans reported poorer quality of life in regard to Social Relationships at follow up (as described above), they did not differ from the comparison group in regard to a number of aspects of functional social support (e.g. perception of being supported) and structural social support (e.g. size of social network). In regard to functional support, the Gulf War veterans were similar to the comparison group on each of the scales of the Medical Outcomes Study (MOS) Social Support Survey including overall support, Tangible support (e.g. having someone to assist you when needed), Affectionate support (e.g. having someone who loves you or shows affection), Positive Social Interaction (e.g. having someone to do enjoyable things with) and Emotional/Informational support (e.g. having someone to confide in, or count on, who

understands you). Functional social support, more so than structural support, is considered a protective factor against stress and the development of psychological health problems.

The Gulf War veterans were also very similar to the comparison groups on measures of structural social support. Gulf War veterans reported very slightly fewer close friends and relatives, but the same level of membership (35-38% of participants) and activity in voluntary groups or organisations such as parent groups, clubs or lodges and church groups.

The two study groups were also fairly equally likely to be involved in ex-service groups (32% vs. 28%) and to commemorate significant military occasions like ANZAC day (72% vs. 70%). The slight increase observed in Gulf War veterans' involvement in ex-service groups is likely to be too small to be of importance. Less than one third of all participants reported being involved in ex-service groups, even though more than 80% of participants were ex-service personnel at the time of the follow up study, having been discharged from the ADF.

In summary, 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 these adverse health outcomes however, could lead to a gradual decline in the social health of Gulf War veterans over time.

5.20 Health services utilisation and DVA healthcare support

Information about participants' health service utilisation, including consultations with health professionals, hospitalisations and pharmaceutical use, was sourced from a combination of self-reported data and recorded data available in the DVA-held health datasets and Australian Medicare Benefits Schedule (MBS) and PBS and RPBS databases. DVA disability claims and DVA Treatment Entitlements Card data were obtained from DVA-held data only. It was not intended that these data sources be compared, rather, used in combination to provide a more complete description of health service and pharmaceutical use than that which would be achievable with any one data source alone.

It was mostly in the area of DVA provided healthcare support that statistically significant differences between the Gulf War veterans and the comparison group were observed. Gulf War veterans lodged two thirds of all disability claims observed in the period 1 January 2001 to 15 August 2012. The proportion of total claims accepted, however, was not higher for the Gulf War veteran group, with approximately two thirds of all claims accepted in both groups. Gulf War veterans were 24% more likely than the comparison group, however, to have made at least one disability claim which was accepted. About one half of the claims submitted by the Gulf War veterans were for illnesses or disabilities attributed to Gulf War service, whereas almost 85% of comparison group claims were attributed to peacetime service.

Gulf War veterans were 43% more likely than the comparison group to have made at least one accepted claim under VEA legislation, and 76% more likely to have had a non-service-related claim accepted. DVA-funded hospitalisation was 71% more likely in the Gulf War group relative to the comparison group for the period January 2007 to August 2012. DVA-hospitalised Gulf War veterans were about one third as likely as hospitalised comparison group participants to have a principal diagnosis of 'neoplasms'. Further, Gulf War veterans (11%) were more than twice as likely as the comparison group (5%) to have been issued a Gold Card. Based on PBS and RPBS data, the average number of scripts dispensed to Gulf War veterans, in the 12 months before follow up, was 63% higher than that in the comparison group.

Some other indications of differences in the pattern of health service utilisation in Gulf War veterans relative to the comparison group, did not reach statistical significance. Generally, DVA hospitalised Gulf War veterans were more likely than hospitalised comparison group participants to have 'mental and behavioural disorders' or 'injury' as the principal diagnosis, and less likely to have 'circulatory disease' as the principal diagnosis. Self-report- and DVA-hospitalisation results indicate that Gulf War veterans were likely to be hospitalised for a little longer than comparison group participants.

Combined DVA- and Medicare-MBS data showed that consultations with neurologists, gastroenterologists, psychiatrists, respiratory physicians and dermatologists were similar between the two study groups and very uncommon in the previous ten years; recorded for 4% or less of all participants. These results indicate that some of the excesses in adverse health outcomes observed in the Gulf War veterans at follow up, such as increased neurological symptoms, increased risk of irritable bowel syndrome, PTSD and alcohol disorder, increased symptoms of sputum, wheeze and cough, and increased self-reported doctor-diagnosed dermatitis and eczema, have not resulted in increased consultation with

medical specialists for these health outcomes, which could be considered an indicator of severity.

The two study groups also did not differ on their likelihood of consulting general practitioners (GPs), dentists and a variety of allied health professionals including physiotherapists or hydrotherapists, psychologists or accredited counsellors or social workers, chiropractors or osteopaths, audiologists or audiometrists, naturopaths, dieticians or nutritionists, alcohol workers or diabetes educators.

The data does show, however, that both groups were highly likely to have accessed health services in the year prior to follow up. Between 64% and 85% of all participants had consulted with a GP, for example, in the previous year. In fact, the self-reported rates of consultation in the previous 12 months with a variety of health professions were markedly higher amongst the study participants at follow up than the rates reported in population data for Australian men. For example, consultation with a dentist or dental professional in the previous 12 months was reported by 68% of participants, a rate which is a little higher than the 62% estimated for Australian adults each year.⁵¹ Compared with the 2007-8 National Health Survey data for Australian men,⁷¹ follow up study participants were noticeably more likely to report having consulted with a physiotherapist or hydrotherapist (22% vs 9%), chiropractor (14% vs 8%), dietician or nutritionist (7% vs 4%) or accredited counsellor (11% vs 2%). The fact that approximately 40% of all participants had been issued either a DVA Gold Card, a White Card, or both may be a factor in the participants' increased access to health services relative to their Australian peers. The follow up study participants' use of pharmaceuticals, however, seems relatively low, with only one third of participants having filled a script in the previous 12 months. In comparison, a recent survey of Australian men over the age of 50 showed that 79% had recently used prescription medications.⁷²

There were some limited indicators in the data that shed light on the types of medical conditions for which the combined study participants were seeking health services. For example, the most frequent primary diagnosis for DVA hospitalisations was 'musculoskeletal system and connective tissue', recorded for 44% of all hospitalisations, and more than half of the disability claims accepted under VEA or MRCA legislation were under the 'Musculoskeletal system and connective tissue system' Statement of Principle (SOP). These findings, in combination with the observation made above that participants were more likely than the Australian population to consult with physiotherapists, hydrotherapists or chiropractors, indicate that musculoskeletal disorders were responsible for a substantial proportion of health service use. The second most frequent primary diagnosis for DVA hospitalisation was 'digestive system' and the third was 'mental and behavioural disorder'.

Other SOPs most frequently cited for claims accepted under VEA or MRCA legislation were the 'Nervous system, Sense organs', 'skin and subcutaneous tissue', 'injury', 'mental disorders' and 'neoplasms' SOPs respectively. The main limitation of these findings however, was that they may not necessarily reflect the health outcomes which were most prevalent in the study participants, but rather they may reflect those health outcomes for which there was a clearer process, ease of acceptance and access to treatment in the DVA health system.

5.21 Health risk factors

In Australia, almost one third of ill health, disability and premature deaths can be attributed to health risk factors.⁵¹ The health risk factors that we 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. Socioeconomic indices which might influence health, such as income, education, service branch and rank, were also assessed, as were life events that might influence health such as trauma exposure and combat exposure.

On the whole, the two study groups were similar in regard to the health behaviours and biomedical factors investigated, suggesting that these determinants of health were not driving the excess morbidity observed in Gulf War veterans. However, the findings highlighted a few areas where some targeted intervention could improve the overall health of both study groups. Only five percent of all participants ate the minimum recommended serves of vegetables per day,⁷³ and 55% of participants ate the minimum recommended serves of fruit.⁷³ Four out of five participants in both study groups were overweight or obese, and all measured indicators of body fat had increased significantly in the ten years since baseline. Finally, approximately 60% of participants reported exercise levels that were rated as low or sedentary. It would be safe to say that interventions which increase physical activity and improve dietary habits will decrease body fat and, combined, these changes in health risk factors will improve overall health in the two study groups.

A very positive finding in this follow up study was the large reduction in the tobacco smoking rate which had occurred in both study groups in the ten year period since baseline. In both study groups, one half of those who reported being smokers at baseline, were no longer smokers at follow up. That trend was greater than that observed in the Australian population. The ABS reported a halving of the Australian population smoking rate in the 15 years from 1985-2010 but the decline was primarily amongst those aged mid-20s to mid-40s; the rate in

those aged 45 or over (which would represent the majority of our participants) remained stable or increased. At follow up, about 10% of all study participants were current smokers, and that rate was noticeably lower than the 19% reported by the ABS for Australians aged 45-54 years in 2010.⁵¹

The two study groups were also similar in regard to socioeconomic factors, such as income, education and employment, which can be important determinants of health. Service branch and rank could be considered, to some extent, to be proxies for socioeconomic status, and on these factors the two groups did differ. Throughout the analyses, however, statistical adjustment has been included for service branch and rank. Therefore, the differences in health outcomes observed between the two study groups cannot be explained by these possible determinants of health.

Differences between the two groups in regard to military service activities since the Gulf War, such as other deployments and combat exposure, and exposure to trauma (military or civilian) may also be determinants of health in these study groups. However, it was observed that the two groups were equally likely to have been actively deployed, to have deployed in a combat role, and to have experienced a traumatic life event since the baseline study.

To summarise, behavioural and biomedical health risk factors including physical activity, dietary behaviour, body fat and tobacco smoking, socioeconomic determinants of health including education, income, service branch and rank, and deployment (other than the Gulf War) and traumatic event exposure, do not explain the excess in morbidity observed in the Gulf War veterans at follow up.

5.22 Health status and health service utilisation at follow up for participants with disorders at baseline

Multisymptom illness, chronic fatigue, and CIDI-defined 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 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.

More specifically, participants in both study groups with one or more of these disorders at baseline had poorer physical and mental health status on the SF12, poorer social support, poorer overall quality of life and health satisfaction at follow up, and an excess in demoralisation, days out of role due to illness, hospitalisations, GP visits and scripts dispensed. These outcomes may be indicative of the chronicity and poor prognosis associated with these five baseline disorders.

The excess of these disorders at baseline in Gulf War veterans has also resulted in greater use of DVA health support services such as disability claims, particularly for claims attributed to Gulf War service. Gulf War veterans with baseline disorders were significantly more likely than Gulf War veterans without baseline disorders to have an accepted claim attributed to the SOPs for 'musculoskeletal system/connective tissue', 'nervous system/sense organs', 'skin and subcutaneous tissue' or 'mental disorders'. It was unclear as to the extent to which these SOPs might reflect the signs or symptoms of the baseline disorders investigated in these analyses. As discussed earlier, however, the more commonly accepted SOPs may not necessarily reflect the health outcomes of most relevance or importance to Gulf War veterans, but rather those health outcomes for which the process through DVA is most streamlined.

These findings highlight the importance of improved detection and intervention strategies to reduce the excess morbidity observed in the Gulf War veteran population. Failure to achieve this is likely to result in their continued long-term decline in health and well-being, and continued increase in health service utilisation including DVA healthcare services.

5.23 Summary of health outcomes at follow up

At follow up, Gulf War veterans were at statistically significantly increased risk of numerous adverse health outcomes relative to the comparison group. Risk of multisymptom illness at follow up, based on past-month symptoms, was 60% higher in Gulf War veterans, risk of irritable bowel syndrome was 64% higher and risk of chronic fatigue was 41% higher. Gulf War veterans were also at increased risk of 12 month PTSD by 137%, 12 month alcohol disorder by 93% and GHQ-12 caseness for psychological distress by 19%. Of these outcomes, multisymptom illness was the most prevalent, observed in 26-29% of Gulf War veterans and 16-18% of the comparison group. Gulf War veterans reported six of 40 doctor-diagnosed medical conditions significantly more frequently than the comparison group, including PTSD, sinus problems, dermatitis, eczema, pneumonia and impotence. At follow up Gulf War veterans also reported 47 of 63 general health symptoms, and five of 17

neuropathic symptoms, significantly more frequently than the comparison group, also more difficulty with sleeping patterns, greater likelihood of severe daytime sleepiness, greater likelihood of having numerous body areas of pain or tenderness, increased risk of injury which potentially involved concussion, more respiratory symptoms including wheeze, cough and sputum, depression symptoms of greater severity, higher levels of demoralisation, higher risk of self-reported difficulty fathering a pregnancy, a slightly increased risk of interaction with the judicial system and increased risk of recently feeling that life was not worth living. In regard to quality of life at follow up, Gulf War veterans rated their physical, psychological and social quality of life statistically significantly more poorly than the comparison group.

There were also other measures of adverse health outcomes at follow up where the differences between Gulf War veterans and the comparison group did not achieve statistical significance, however the pattern was such that the Gulf War veterans typically scored more poorly. These results include increased risk of 12 month depression, symptom-based chronic bronchitis, in-patient hospitalisation for recent injury, self-reported kidney and bladder disease and eye or vision problems.

The excess of adverse health outcomes in Gulf War veterans relative to the comparison group was also reflected in their significantly increased rate of lodging disability claims with DVA and increased likelihood of having had at least one claim accepted, their increased rate of DVA hospitalisation, their increased likelihood of having been issued a Gold Card and the 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 GPs, medical specialists such as neurologists, gastroenterologists, respiratory physicians and psychiatrists and allied health professionals such as physiotherapists, chiropractors or naturopaths.

For a few health outcomes there was no apparent difference between the two study groups. These include musculoskeletal disorders, structural gastrointestinal disorders such as ulcers, Crohn's disease and colitis, also reflux-related diseases and gall bladder disease, number of injuries in the previous 12 months, psychological disorders other than PTSD, alcohol disorder and depression, risk taking propensity, likelihood of fathering a full-term and normal weight baby and some other self-reported doctor-diagnosed medical conditions including hearing loss, sleep apnoea, heart attack or myocardial infarction, carpal tunnel syndrome and diabetes. There were also no differences between the two groups in their likelihood of having experienced a traumatic event since baseline, or having experienced financial distress, homelessness or incarceration. The Gulf War veterans and the comparison group

were also similar on measures of resilience, overall social support, membership and activity levels in voluntary groups, involvement in ex-service organisations and commemoration of significant military-related occasions.

6 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 possibly health-related 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 PB. Where available, some additional sources of information were used to supplement the self-reported exposure data, such as vaccination data recorded in each participant's International Certificates of Vaccination, ADF-held information about locations and dates of deployment and other information known about significant events during the Gulf War.

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, a number of additional sources of information relevant to Gulf War exposures were reviewed. These include the Reports of Proceedings (RoPs), Ships' Logs and Ships' Medical Journals for the Ships which were 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 different Ship's complements and other groups deployed to the Gulf War. The purpose of this was to determine whether the personnel on any Ships or other deployed groups could be collectively categorised as belonging to a particular stratum of exposure. The association between strata of exposure based on Ship or deployment, and health outcomes in Gulf War veterans at follow up, were then assessed to see if this method of exposure assessment provided information additional to that achieved when the exposure assessment was based primarily on self-reported data.

The documents reviewed provided some support to the robustness of the self-reported levels of exposures. For example, the Ships' Logs and RoPs included reports of dust storms in the vicinity of HMA Ships *Brisbane*, *Sydney* and *Westralia*, and these Ships' companies were amongst those most likely to self-report exposure to dust storms. Malaria prophylaxis was recorded in the Ships' Logs for HMA Ships *Darwin I* and *II*, *Adelaide* and *Success*, those being four of the deployments most likely to self-report taking anti-malarials. A Defence Parliamentary brief on PB use confirmed that personnel on *Brisbane*, *Sydney*, *Westralia* and *Success* were likely to have taken PB, and these companies were also highly likely to self-report PB use relative to other deployments.

One exposure-type of particular concern to Gulf War veterans was the possible exposure to nuclear, biological or chemical (NBC) warfare agents during their deployment. In the baseline study, about 11% of Gulf War veterans reported that they had been in an area

where chemical warfare agents had been used, and 9% reported being exposed to nuclear, biological or chemical warfare. We reviewed the RoPs, Ships' Logs and Ships' Medical Journals for any supporting documentation. There were very large numbers of NBC exercises recorded in the RoPs. Most chemical alarms in the Logs corresponded with an exercise. A very small number of alarms, five on *Sydney*, four on *Darwin II* and one on each of *Success* and *Brisbane* did not correspond with an exercise noted in either the Logs or RoPs. A possible source of exposure to nuclear, biological or chemical warfare agents was vapour from the demolition of the Khamisiyah weapons storage complex in early March 1991. However, our review of the RoPs and Ships' Logs revealed no unexplained chemical alarms during the first two weeks of March 1991, when it might be expected that exposure levels were highest. In summary, these documents did not support the likelihood of nuclear, biological or chemical warfare agent exposure amongst Ship-based Gulf War veterans. A Post-Operation Report for Operation Habitat also did not provide useful information about the likelihood of chemical warfare agent exposure in this land-based group.

Exposure to gastroenteritis outbreaks was not measured by self-report at baseline, however it has since been speculated that gastroenteritis may be associated with postinfectious irritable bowel syndrome in Gulf War veterans.¹¹ The Ships' Medical Journals and RoPs did provide some limited information about possible exposure to gastroenteritis outbreaks, as did the Post-Operation Report for Operation Habitat. Based on these, a deployment-based metric for possible exposure to gastroenteritis outbreaks was created; however it should be noted that any individuals' actual exposure to gastroenteritis could not be deduced from the documents reviewed.

The primary limitations of the documents reviewed were the lack of direct exposure measurements and the fact that the absence of a record does not necessarily equate to the absence of an exposure. For example, records pertaining to oil slicks on water do not equate to a record or measurement of any individual being exposed to that oil by drinking it, showering it or being exposed in some other way. Similarly, the absence of records pertaining to water purification does not mean that water purification was not conducted, nor does the absence of records pertaining to dust storms, or PB use, mean that a particular deployment did not experience these exposures.

Based on the patterns of Ship and deployment-group differences in self-reported exposure and, for some exposures, supporting documentation, some new metrics for exposure assessment were proposed. They are shown in Table 1 along with the health outcomes to be investigated in relation to each exposure. The analyses of associations between Gulf

War-related exposures and health outcomes at follow up included both the new deployment-based metrics and the self-report-based metrics which were used in the baseline study.

Table 1 Health outcomes and environmental, chemical and medical exposure metrics based on Ship and other deployment groups

Exposure Metric	Ship and deployment groups	Health Outcomes
Intense smoke		
High (>90% reported exposure)	<i>Darwin 2, Clearance Divers</i>	General physical wellbeing (SF-12 PCS score), symptom count, chronic bronchitis, asthma, Irritable Bowel Syndrome
Low (<90% report exposure)	<i>Westralia, Sydney, Darwin 1, Brisbane, Comfort 1, 2,3 Success, Adelaide, Operation Habitat, Other deployments (NOS)</i>	
Dust		
High (>40% report exposure)	<i>Darwin 1 and 2, Westralia, Sydney, Brisbane, Clearance Divers, Operation Habitat, Other deployments (NOS)</i>	General physical wellbeing (SF-12 PCS score), symptom count, chronic bronchitis, asthma
Low (<40% report exposure)	<i>Comfort 1, 2 and 3, Success, Adelaide,</i>	
Oil in drinking or showering water		
Possible (>20% report exposure in either category)	<i>Clearance Divers, Brisbane</i>	General physical wellbeing (SF-12 PCS score), symptom count, Irritable Bowel Syndrome
Unlikely oil in drinking or showering water	All other groups	
Pesticide exposure reporting		
Higher (>30% in any of 4 exposure categories; treated clothing & tent, worked in sprayed area and pesticide application)	<i>Operation Habitat</i>	General physical wellbeing (SF-12 PCS score), symptom count, neuropathic symptom count, multisymptom illness, chronic fatigue
Lower (<30% in all 4 exposure categories)	All other groups	
Outbreaks of, or increased possibility of gastroenteritis during deployment		
Yes	<i>Darwin 1 and 2, Brisbane, Sydney, Westralia, Operation Habitat and Clearance Divers</i>	Irritable Bowel Syndrome
No	All other groups	
Likelihood of taking PB based on self-report		
High uptake	<i>Success, Brisbane, Sydney, Westralia, Clearance Divers</i>	General physical wellbeing (SF-12 PCS score), symptom count, neuropathic symptom count, multisymptom illness, chronic fatigue, Irritable Bowel Syndrome
Low uptake	<i>Adelaide, Darwin 1 and 2, Comfort, Operation Habitat</i>	
Recorded vaccinations		
High vaccination	<i>Darwin 1 and 2, Brisbane and Sydney, Operation Habitat and Clearance Divers</i>	General physical wellbeing (SF-12 PCS score), symptom count, neuropathic symptom count, multisymptom illness, chronic fatigue
Moderate vaccination	<i>Westralia, Comfort and Other deployments</i>	
Low vaccination	<i>Adelaide and Success</i>	

6.1 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 in Gulf War veterans at follow up. Lower rank at the time of the 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.

The exposure analyses results for PB tablets and vaccinations are shown in Table 2 and Table 3. 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.

Tabulated results for other chemical, environmental and medical exposures can be found in the Technical Report. Self-reported pesticide exposure was associated with poorer physical health status, increased symptom reporting and risk of multisymptom illness, and chronic fatigue. Self-reported SMOIL exposure was associated in a dose response relationship with poorer 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.

The exposure analyses results for Gulf War deployment-related stressors, as measured using the Military Service Experience Questionnaire (MSEQ) are shown in Table 4. 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, AUDIT alcohol caseness and GHQ12 psychological distress at follow up.

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.

Table 2 Association between use of PB during the Gulf War and health outcomes at follow up in Gulf War veterans

Level of PB exposure	SF12 PCS score		Health symptom count		Neuropathic symptom count		Multisymptom illness (N=203)		Chronic fatigue (N=86)		Rome III IBS case (N=90)	
	Mean (sd)	Adj diff (95% CI)	Mean (sd)	Adj ratio (95% CI)	Mean (sd)	Adj ratio (95% CI)	n (%)	Adj RR (95% CI)	n (%)	Adj RR (95% CI)	n (%)	Adj RR (95% CI)
Deployment-based metric												
Low uptake	46.9 (10.5)	0.0	16.1 (11.1)	1.0	2.1 (2.8)	1.0	92 (26.9)	1.0	42 (12.2)	1.0	34 (10.2)	1.0
High uptake	46.5 (10.1)	-0.54 (-2.2, 1.2)	17.8 (12.4)	1.1 (<1.0-1.2)	2.3 (3.1)	0.9 (0.7-1.2)	111 (31.6)	1.2 (0.9-1.6)	44 (12.5)	0.9 (0.6-1.4)	56 (16.4)	1.7 (1.1-2.7)
Self-report based metric												
None	47.4 (10.5)	0.0	14.0 (11.1)	1.0	1.7 (2.5)	1.0	48 (24.4)	1.0	20 (10.2)	1.0	17 (8.9)	1.0
Any	46.7 (10.0)	-1.0 (-3.0, 1.0)	18.1 (12.3)	1.3 (1.1-1.5)	2.3 (3.1)	1.2 (0.9-1.6)	110 (31.4)	1.3 (<1.0-1.9)	45 (14.3)	1.1 (0.7-1.9)	55 (16.2)	1.9 (1.1-3.3)
1-80 tablets	48.0 (9.0)	0.2 (-2.4, 2.8)	15.2 (11.6)	1.1 (0.9-1.4)	1.6 (2.2)	0.9 (0.6-1.4)	24 (28.9)	1.3 (0.8-2.0)	8 (9.6)	1.0 (0.5-2.1)	13 (16.5)	2.2 (1.1-4.8)
81-180 tablets	46.6 (9.4)	-1.3 (-4.0, 1.4)	18.5 (12.5)	1.4 (1.1-1.7)	2.4 (3.0)	1.0 (0.6-1.5)	28 (37.8)	1.7 (1.1-2.6)	11 (14.9)	1.4 (0.7-2.8)	11 (15.1)	1.9 (0.9-4.0)
>180 tablets	46.9 (11.0)	-1.0 (-4.4, 2.4)	17.9 (12.4)	1.3 (1.1-1.6)	2.2 (3.2)	1.1 (0.7-1.8)	21 (32.8)	1.5 (0.9-2.4)	8 (12.5)	1.1 (0.5-2.6)	8 (12.9)	1.5 (0.6-3.7)
Dose response	-	-0.42 (-2.19, 1.35)	-	1.08 (0.97-1.22)	-	1.12 (0.89-1.40)	-	1.05 (0.83-1.34)	-	1.03 (0.67-1.61)	-	0.86 (0.56-1.32)
Don't know	45.7 (10.7)	-2.5 (-4.9, 0.02)	18.2 (10.8)	1.3 (1.1-1.6)	2.7 (3.2)	1.4 (1.1-2.0)	45 (31.3)	1.4 (<1.0-2.1)	21 (14.3)	1.5 (0.8-2.6)	18 (12.7)	1.5 (0.8-3.2)

Table 3 Association between vaccinations for the Gulf War deployment and health outcomes at follow up in Gulf War veterans

Level of vaccination exposure	SF12 PCS score		Health symptom count		Neuropathic symptom count		Multisymptom illness (N=203)		Chronic Fatigue (N=117)	
	Mean (sd)	Adj diff (95% CI)	Mean (sd)	Adj ratio (95% CI)	Mean (sd)	Adj ratio (95% CI)	n (%)	Adj RR (95% CI)	n (%)	Adj RR (95% CI)
Deployment-based metric										
Low	46.4 (10.1)	0.0	16.6 (11.1)	1.0	2.3 (3.0)	1.0	47 (30.0)	1.0	22 (13.8)	1.0
Medium	46.9 (10.4)	0.7 (-2.9, 3.0)	15.6 (10.9)	1.0 (0.8-1.2)	1.9 (2.4)	1.1 (0.7-1.6)	36 (27.3)	1.0 (0.6-1.5)	15 (11.4)	1.1 (0.5-2.4)
High	46.7 (10.4)	0.5 (-1.4, 2.3)	17.5 (12.2)	1.0 (0.9-1.2)	2.3 (3.1)	1.0 (0.8-1.3)	120 (29.8)	1.0 (0.7-1.3)	49 (12.1)	0.8 (0.5-1.3)
Self-report based metric										
None	45.7 (11.1)	0.0	16.9 (12.0)	1.0	2.1 (3.0)	1.0	31 (27.4)	1.0	15 (13.3)	1.0
Any	47.7 (9.8)	1.7 (-0.6, 4.0)	15.8 (11.4)	0.9 (0.8-1.1)	2.0 (2.6)	1.0 (0.8-1.4)	117 (27.6)	1.1 (0.8-1.5)	49 (11.5)	0.9 (0.5-1.5)
1-4	48.4 (9.6)	2.3 (-0.2, 4.8)	14.4 (10.4)	0.9 (0.7-1.0)	1.6 (2.2)	1.0 (0.7-1.4)	35 (20.6)	0.8 (0.5-1.2)	16 (9.4)	0.7 (0.4-1.4)
5-9	48.0 (9.8)	1.8 (-0.6, 4.3)	15.8 (11.3)	0.9 (0.8-1.1)	1.9 (2.6)	1.0 (0.7-1.4)	64 (29.1)	1.1 (0.8-1.7)	22 (10.0)	0.8 (0.4-1.4)
10 or more	43.0 (9.8)	-3.0 (-7.1, 1.0)	23.3 (14.4)	1.4 (1.1-1.7)	1.9 (2.6)	1.8 (1.1-2.9)	18 (52.9)	2.1 (1.3-3.3)	11 (32.4)	2.5 (1.2-5.0)
Dose response [§]	-	-0.39 (-0.80, 0.01)	-	1.03 (1.01-1.06)	-	not computed	-	1.10 (1.03-1.16)	-	1.16 (1.05-1.28)
Don't know [‡]	44.5 (10.7)	-1.3 (-4.3, 1.7)	19.9 (11.9)	1.1 (0.9-1.3)	3.0 (3.7)	1.3 (0.9-1.9)	54 (35.1)	1.3 (0.9-2.0)	22 (14.2)	1.0 (0.5-1.9)
No clustering	47.0 (10.2)	0.0	16.3 (11.5)	1.0	2.0 (2.7)	1.0	135 (27.9)	1.0	57 (11.8)	1.0
Any clustering	47.9 (9.8)	0.5 (-1.9, 2.9)	16.1 (12.1)	1.01 (0.8-1.2)	2.0 (3.0)	1.1 (0.7-1.5)	20 (27.4)	1.0 (0.7-1.5)	11 (15.1)	1.4 (0.8-2.6)

Table 4 Association between Gulf War deployment MSEQ score and health outcomes at follow up in Gulf War veterans

Gulf War deployment exposure	SF12 MCS score		Health symptom count		Neuropathic symptom count		Multisymptom illness (N=203)		Chronic fatigue (N=86)		Irritable Bowel Syndrome (N=90)	
	Mean (sd)	Adj diff (95% CI)	Mean (sd)	Adj ratio (95% CI)	Mean (sd)	Adj ratio (95% CI)	n (%)	Adj RR (95% CI)	n (%)	Adj RR (95% CI)	n (%)	Adj RR (95% CI)
MSEQ score												
0-4	51.2 (9.3)	0.0	10.3 (8.4)	1.0	1.1 (1.8)	1.0	14 (9.0)	1.0	13 (8.4)	1.0	10 (6.5)	1.00
5-8	47.5 (11.0)	-3.8 (-6.0, -1.7)	14.9 (9.7)	1.5 (1.3-1.7)	1.7 (2.7)	1.2 (0.9 – 1.7)	43 (20.9)	2.4 (1.3-4.2)	19 (9.2)	1.0 (0.5-2.0)	24 (12.1)	1.88 (0.91-3.87)
9-12	44.6 (12.3)	-6.9 (-9.3, -4.5)	19.5 (12.4)	1.9 (1.6-2.2)	2.9 (3.4)	1.7 (1.2 – 2.4)	62 (35.6)	4.0 (2.3-6.8)	21 (12.0)	1.3 (0.7-2.6)	29 (17.2)	2.65 (1.31-5.37)
>12	40.9 (12.4)	-10.3 (-12.9, -7.8)	23.3 (12.3)	2.3 (2.0-2.7)	3.1 (3.3)	1.9 (1.4 – 2.8)	84 (53.5)	6.1 (3.6-10.4)	33 (20.9)	2.3 (1.2-4.3)	27 (17.7)	2.86 (1.42-5.77)
Dose response	-	-0.72 (-.08, -0.56)	-	1.06 (1.05-1.07)	-	1.04 (1.02 – 1.07)	-	1.09 (1.08-1.11)	-	1.07 (1.04-1.10)	-	1.05 (1.03-1.09)

Gulf War deployment exposure	12 month Major depression (N=63)		PHQ-9 depressive symptom score		12 month PTSD (N=47)		12 month Alcohol disorder (N=40)		AUDIT case (N=199)		GHQ-12 case (N=264)	
	n (%)	Adj RR (95% CI)	Median (IQR)	Adj diff (95% CI)	n (%)	Adj RR (95% CI)	n (%)	Adj RR (95% CI)	n (%)	Adj RR (95% CI)	n (%)	Adj RR (95% CI)
MSEQ score												
0-4	7 (4.8)	1.0	1 (0-4)	0.0	0	-	5 (3.5)	1.0	33 (21.3)	1.0	36 (23.2)	1.0
5-8	17 (8.7)	1.9 (0.8-4.4)	3 (0-6)	1 (-0.3-2.3)	11 (5.6)	1.0 ^S	10 (5.1)	1.4 (0.5-4.1)	50 (24.3)	1.1 (0.7-1.6)	73 (35.3)	1.5 (1.1-2.2)
9-12	16 (10.1)	2.2 (0.9-5.2)	4 (2-8)	2 (0.6-3.4)	12 (7.6)	2.2 (>1.0-4.9)	11 (7.0)	1.9 (0.7-5.5)	58 (33.5)	1.5 (1.1-2.2)	75 (42.9)	1.9 (1.3-2.6)
>12	23 (15.6)	3.2 (1.4-7.4)	7 (3-12)	5 (3.6-6.4)	24 (16.3)	4.6 (2.3-9.1)	14 (9.5)	2.5 (0.9-6.7)	57 (36.5)	1.6 (1.1-2.4)	80 (51.3)	2.2 (1.6-3.1)
Dose response	-	1.06 (1.02-1.09)	-	0.36 (0.27-0.46)	-	1.13 (1.10-1.17)	-	1.05 (>1.00-1.10)	-	1.04 (1.02-1.06)	-	1.04 (1.03-1.06)

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. Those taking PB tablets, for example, were primarily deployed as part of Damask II which included the combat phase of the Gulf War and the torching of the oil wells resulting in SMOIL. Clearance Divers and the companies of HMA Ships *Brisbane* and *Sydney* who were categorised as ‘high uptake’ for PB, were also categorised as ‘high’ for vaccination exposure and dust. Clearance Divers were also categorised as ‘high’ for intense smoke, oil in water and possible outbreaks of gastroenteritis. Gulf War veterans who reported the most deployment-related stressors were most likely to have served under junior ranks at the time of the Gulf War and during the combat phase.

7 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. Linkage of the cohort to the National Death Index and the Australian Cancer Database was conducted in July 2011. Data was obtained for the period 1st January 1991 to 30th of November 2010 for mortality and to 31st of December 2008 for cancer incidence.

In the 20 year period following the Gulf War, there has been a total of 108 deaths, comprising 2% of the male cohort. Proportionately there have been slightly fewer deaths in total in the veteran group compared to the same aged Australian male population (SMR 77, 95% CI 58-102) and slightly more deaths in the Gulf War veterans relative to the comparison group (adj HR 137, 95% CI 94-202). Compared to the Australian population, Gulf War veterans have been at slightly lower risk of 'all-cause' mortality and mortality from cardiovascular diseases and intentional self-harm, but slightly higher risk of mortality from cancer-related causes. Relative to the comparison group, increased risk of mortality among Gulf War veterans has been greatest for cancer-related mortality (adj HR 182, 95% CI 88-374) and 'all-cause' mortality (adj HR 137, 95% CI 94-202). However, none of these differences in mortality rates between the Gulf War veterans and Australian population, and the Gulf War veterans and comparison group, achieved statistical significance and therefore the possibility of these findings being observed by chance cannot be excluded. However, statistical power was very limited due to small numbers. In the same time period all-cause mortality rates (SMR 59, 95% CI 45-76) and mortality from all external causes (SMR 61, 95% CI 41-92) have been statistically significantly lower in the male comparison group than in the same aged Australian male population.

The pattern of findings in relation to all-cause mortality for both study groups and the Australian population was very similar to that observed in the baseline study. Lower SMRs for 'all cause' mortality in the two study groups were consistent with a 'healthy worker effect' whereby workers are, on average, healthier than the general population. Armed forces are generally even healthier than the general population⁷⁴ as a result of self selection, medical screening upon recruitment for suitability for military service, ongoing medical screening and maintenance of fitness while serving, access to medical services while serving, and early discharge from the services of the medically unfit. This difference between armed forces personnel and the general population has been termed the 'healthy soldier effect'. It is encouraging to observe that the 'healthy soldier effect' continued to be present in both study groups, with overall death rates lower than expected. However, the effect size was weaker

in the Gulf War veteran group, and that may reflect adverse health outcomes consequent to the Gulf War deployment. The increased SMR for cancer-related mortality observed in the veteran group, whilst not statistically significant, is worth noting. Some studies have shown that the healthy worker effect is weaker for cancers,⁷⁵ which might explain the lack of this effect on cancer-related mortality in Gulf War veterans.

Further information about the incidence of cancer in the two study groups was identified by linkage with the Australian Cancer Database. In the 18 year period following the Gulf War, there have been 115 cancers detected; affecting 2.5% of the male cohort. When all cancer types were combined, there were almost exactly the same number of cancers observed in the veteran group as that expected in the Australian male population (SIR 99). There were slightly fewer cancers observed in the comparison group than expected (SIR 83). The risk of cancer in the Gulf War veterans was very slightly higher than in the comparison group (HR 120). 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. There were no other statistically significant differences in cancer incidence of any type between the Gulf War veterans or the comparison group and the Australian population, or between the Gulf War veterans and the comparison group. 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.

The conclusions to be drawn from the combined mortality and cancer incidence study results were not particularly clear, mainly due to the small numbers of deaths and cases of cancer at this stage. Overall, the mortality rates and cancer incidence rates in both study groups were lesser or comparable to those observed in the Australian community. This was a positive, but not unexpected, result considering that the cohort was still relatively young and had above average fitness upon enlistment with the ADF. Of some concern, however, was the very slight elevation in cancer-related deaths amongst the Gulf War veterans, relative to both the Australian population and the comparison group, paired with the very slight elevation in overall cancer incidence in Gulf War veterans relative to the comparison group, which will need careful monitoring into the future.

The current mortality findings do not support the US Institute of Medicine's 2010 judgement that the weight of the scientific studies have provided "*limited/suggestive evidence of an association*" between deployment to the Gulf War and mortality from external causes,

primarily motor-vehicle accidents, and the current cancer incidence findings are largely consistent with the determination that there is, as yet, “*inadequate/insufficient evidence to determine whether an association exists*” between deployment to the Gulf War and any cancer.¹¹

8 Strengths and Limitations of the Follow Up Study

Combined, the Australian Gulf War veterans' mortality and cancer incidence study, and the Follow Up Health Study, have a number of strengths which give confidence to the observed findings, but also some limitations which affect interpretation.

A major strength of the combined studies was the inclusion of a large military comparison group who were in operational units at the time of the Gulf War. Randomised and frequency matched to the Australian Gulf War veterans, the comparison group was considered equally fit to deploy and provided an excellent benchmark against which the health of the Gulf War veterans could be compared with minimal risk of a healthy worker/soldier effect. The matching of the two groups on age-category, rank category and service branch, and additional statistical adjustment for these possible health confounders throughout the analyses, renders it unlikely that differences between the two study groups on these factors could explain post-Gulf War health differences.

The mortality and cancer incidence study included the entire cohort of Australian ADF personnel who deployed to the Gulf War and the entire comparison group, other than two who opted out, and therefore participation bias would not affect the results. Additional strengths, of the mortality and cancer incidence study findings, relate to the relative completeness and accuracy of the National Death Index and Australian Cancer Registry datasets upon which the study results are based.

Whilst mortality rates were able to be tracked for approximately 20 years post deployment, and cancer incidence for approximately 18 years post deployment, the power of the study to detect excess mortality and cancer continues to be limited. The cohort was still quite young at 30 November 2010 (the date to which NDI data was available), with approximately 40% aged between 35-44 years, and the period of follow up was still relatively short for the purpose of detecting disease-related deaths for cancers of long-latency.

The Follow Up Health Study achieved a lower participation rate than that achieved at baseline, with a consequent reduction in statistical power. Smaller numbers of cases with the health outcomes of interest, than that which might have been achieved with a higher participation rate, limited the study's ability 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. However, the participation rate was comparable with, or better than, other recent Gulf War veteran studies.

The lower participation rate also rendered the study vulnerable to participation bias, which can occur if participants differ from non-participants on characteristics associated with the study dependent measures, such as health status. We were able to compare participants and non-participants using data collected at the time of the baseline study, to assess the extent to which participants were representative of the study groups from which they were drawn. The findings supported the statistical adjustment conducted throughout the analyses for age, service branch and rank, however it was largely concluded that participation bias was unlikely to explain the post-Gulf War health differences between groups.

To maximise the robustness and comprehensiveness of the follow up study results, the study design included a number 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. The study also used Gulf War deployment exposure information which was collected from participants at baseline, and supplemented by a review of additional ADF documentation, rather than relying on participants' recall more than 20 years after deployment. Combined, the various methods of data collection provided a more complete picture of health and exposure in the two study groups than that which could have been achieved by any one method alone, and minimised the potential for recall bias, personal motivation or other factors which might have influenced the results.

Specific advantages of accessing DVA, MBS, PBS and RPBS data included that the data were available electronically, linkage could be repeated into the future, real time data inputs minimised error, there was incentive for patients and providers to provide data as payments were dependent on it, and DVA and Medicare Australia had numerous processes in place to check and verify the data. Limitations, however, included the fact that PBS and RPBS data did not capture all medications and the number of scripts dispensed 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 participants. DVA data may have reflected health policy, or ease of access, acceptance or treatment for certain types of health outcomes, rather than the pattern of health outcomes amongst its constituents. If it could be assumed, however, that the Gulf War veterans and the comparison group were treated equally within those databases, then differences in health service utilisation observed between the two groups could be confidently attributed to group characteristics and not database characteristics.

9 Implications for Policy and Programs

The follow up study results highlight the importance of effective detection and management of existing chronic conditions in Australian veterans of the 1990-1991 Gulf War such as multisymptom illness, chronic fatigue syndrome, irritable bowel syndrome, PTSD and alcohol disorder.

Ongoing monitoring of Gulf War veterans is important for the purpose of early detection and prevention of long-latency disease 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, is important to facilitate earlier detection and intervention.

Improved strategies to specifically target psychological health, including suicide prevention, are needed given the clear association between PTSD and Gulf War deployment, and the elevated levels of demoralisation, psychological distress and suicidal ideation in the veteran group.

Programs and interventions that effectively maintain and bolster Gulf War veterans' social health, particularly functional social support, may also both protect against disease and enhance recovery and productivity.

Programs aimed at positively changing health behaviours, particularly in the areas of healthy eating and physical exercise, will be of benefit to the overall health of both study groups in this follow up study.

The study results increase the evidence base for greater recognition in Australia of Gulf War-related multisymptom illness.

10 Implications for Future Research

The two major studies of health in Australia's Gulf War veterans; i.e. the baseline study at approximately ten years after deployment, and this Follow Up Health Study more than 20 years after deployment, have both shown persisting and pervasive chronic ill health in Gulf War veterans at levels which are in excess relative to their peers. Rather than a continued focus on the difference in health between Gulf War veterans and peers, future studies of the Gulf War veteran group might consider measuring the extent to which interventions in regard to physical, psychological and social health and health behaviours, improved detection of adverse health outcomes and policy change have alleviated or slowed the excess in risk in Gulf War veterans. The Gulf War Veterans' Health Study has been designed as a prospective cohort study and future monitoring of the Gulf War veterans, with a focus on repeat linkages with the NDI, ACD, 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 Australian Defence Force 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. The purpose of this is to minimise the risk of response bias and inaccuracies through recall bias and provide more robust evidence for associations between specific exposures and health outcomes.

11 Conclusions

More than 20 years after the Gulf War, the Australian Gulf War Veterans' Follow Up Health Study results demonstrate that Australian veterans of the Gulf War have poorer physical health, psychological health and quality of life, greater use of DVA-health services and greater use of pharmaceuticals relative to the comparison group of ADF personnel who did not deploy to the Gulf War. Relative to the comparison group, risk was particularly elevated in the Gulf War veteran group for PTSD, multisymptom illness, chronic fatigue, irritable bowel syndrome and alcohol disorder. Of these disorders, multisymptom illness was the most prevalent, observed in 26-29% of Gulf War veterans and 16-18% of the comparison group. The two study groups, however, were similar in regard to their overall life satisfaction and health satisfaction, their levels of resilience, social support and community participation, and their likelihood of accessing GPs, medical specialists and other health professionals. While there were no statistically significant excesses in the mortality and cancer incidence rates of the Gulf War veterans, there were some causes of death and types of cancer for which numbers were small, but which were suggestive of an excess.

Several Gulf War deployment characteristics and exposures were associated with numerous adverse health outcomes in Gulf War veterans at follow up. These included lower rank at the time of the Gulf War deployment, deployment during the combat-phase, and also PB tablets, number of vaccinations, pesticide exposure, SMOIL and deployment-related stressors based on self-reported data. During the Gulf War deployment, however, many of these exposures overlapped. This limits the certainty with which any one exposure can conclusively be linked to any one health outcome.

The study results highlight the need for improved detection, prevention and management of adverse health conditions in Gulf War veterans, greater awareness by medical professionals of conditions common to Gulf War veterans such as multisymptom illness, and strategies to improve psychological health, social health and health behaviour.

Future studies are recommended which measure the extent to which interventions, improved detection or policy change have alleviated or slowed the excess in risk in Gulf War veterans. It is also recommended that studies involving future deployments include pre-deployment health data, in-time exposure monitoring, recruitment soon after deployment, data linkage and longitudinal monitoring.

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