The impacts of deployment related exposures on respiratory health of Australian Defence Force members

Thesis submitted for the degree of Master of Philosophy (Medicine)

by

Honey Ighani

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The University of Adelaide, Australia
Centre for Traumatic Stress Studies
School of Medicine

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Summary

Background

Recent evidence from international literature suggests an elevated prevalence of adverse respiratory conditions among military personnel during and following deployment to the Middle East. Australian Defence Force (ADF) members may also be at risk for developing respiratory conditions. However, there is a paucity of prospective studies regarding the level of respiratory distress and identification of potential factors leading to adverse respiratory outcomes among ADF members post- deployment.

Aims and hypotheses

The aims of this thesis are: 1) To investigate if, similar to the reported international literature, there is an increase in subjective respiratory symptoms (self-reported respiratory symptom measured using a medical and respiratory questionnaire) of ADF members from pre- to post-deployment to the MEAO between 2010 and 2012 and whether these are accompanied by any changes in objective function (FEV1/FVC lung function measured by spirometry), possibly at a sub-clinical level. (Chapter 3 presents and discusses this topic). 2) To examine the predictors of adverse respiratory outcomes among this cohort in the context of combat environmental and psychological trauma exposures (Chapter 4 provides detailed investigation of predictors of adverse respiratory outcomes).

In light of findings from the existing literature, it was hypothesised that there would be an observable decline in both objective and subjective respiratory function of contemporary ADF members from pre-to post-deployment to MEAO between 2010 and 2012. Further, it was also postulated that environmental and psychological trauma exposures would independently and combined contribute to changes in self-reported respiratory symptoms and objective respiratory measures in this cohort of ADF members.

Methods

Data from the MEAO prospective study were analysed to investigate the effect of deployment related exposures on adverse respiratory outcomes. From a total sample of 3074 who were deployed to the MEAO between 2010 and 2012, a specific subsample was utilised in this thesis, including the 202 ADF members in combat roles with complete reliable spirometry results at pre-and post-deployment, who also completed self- reported questionnaires.

Self-reported respiratory symptoms, and objective measures of respiratory function (Forced Expiratory Volume in one second (FEV1), Forced Vital Capacity (FVC), and FEV1/FVC ratio) were assessed at both pre and post-deployment. Self-reported environmental and psychological trauma exposures incurred during deployment were assessed at post-deployment.

Results

While the majority of individuals were still within the normal range of objective respiratory function, analyses of both objective and subjective data showed that there were significant decreases in both objective and self-reported respiratory function following deployment. In addition, the decline in objective function was found to be significantly associated with self-reported respiratory symptoms. The results showed that environmental and psychological trauma exposures experienced on deployment were independently associated with adverse respiratory outcomes on both objective and self-report measures. Importantly there was also a significant interaction, with the association between environmental exposures and both objective and self-reported respiratory measures stronger under conditions of high compared to low psychological trauma exposure.

Conclusions

The findings of this study support the hypothesis that there would be a decline in objective and subjective respiratory function of ADF members following deployment to the MEAO. Furthermore, environmental and psychological trauma exposures experienced on deployment

both contributed to these changes. The results suggest that psychological trauma may increase vulnerability to the effects of environmental exposures on respiratory outcomes. One possible mechanism underpinning the association between psychological stress and reduced respiratory function could be increased levels of systemic inflammatory mediators, leading to increased susceptibility to environmental exposures, via a compromised immune system. Another possibility is that the cumulative burden of all exposure types impacts respiratory function. However, it is also important to consider that it is likely that environmental and psychological exposures were somewhat confounded due to the nature of the deployed environment; environmental exposures such as being exposed to blast or toxins is likely to have carried a burden of psychological stress.

While the aetiology behind the findings showing that psychological trauma exposures are associated with physical health changes remains unclear, the effect of psychological factors on the relationship between environmental exposures and respiratory function cannot be excluded as a potential contributing factor, suggesting that strategies should be developed and implemented to reduce the effects of these exposures on military personnel during deployment. A decrement in lung function below 70% is quite considerable. A recommendation could be to detect possible adverse respiratory health at an early stage to prevent long-term respiratory disease, and to recommend proactive interventions for prevention.

Declaration

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name, in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name, for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint-award of this degree.

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Signature

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Abbreviations

Abbreviation	Description
ADF	Australian Defence Force
CTSS	Centre for Traumatic Stress Studies
MEAO	Middle East Area of Operations
PTSD	Post Traumatic Stress Disorder
FEV1	Forced Expiratory Volume in 1 second
FVC	Forced vital Capacity
US	United States
UK	United Kingdom
MilHOP	Military Health Outcomes Program
PCL-C	Post-traumatic Stress Disorder Check List Civilian
AUDIT	Alcohol Use Disorders Identification Test
ADHREC	Australian Defence Human Research Ethics Committee
ICD-9	International Classification of Diseases-9
OIF	Operation Iraqi Freedom
OEF	Operation Enduring Freedom
NYC	New York City
SMOIL	Smoke from Oil
GW1	First Gulf War
COPD	Chronic Obstructive Pulmonary Disease
WTC	World Trade Centre

Chapter 1 – Background and Introduction

1.1 Commentary

Current international literature suggests a higher prevalence of respiratory conditions among military personnel during and subsequent to deployment to the Middle East for reasons that are not well understood. Most research has focussed on the role of environmental exposures such as air pollution from local combustion sources, including burn pits, fire, fuel used in vehicles and cigarette smoking ubiquitous to the deployed environment that may be implicated in adverse health outcomes. However, little research has focused on the potential role of psychological stress and trauma on these effects, despite a large body of literature highlighting the comorbidity between poor psychological and physical health, and a growing understanding of the links between stress exposure and respiratory conditions.

This thesis addresses a gap in knowledge regarding a lack of understanding of how psychological trauma may contribute to changes in respiratory health in the deployed population, particularly considering that psychological stress and trauma are high in this population. The use of a prospective design allows documentation of sub-clinical changes in health that may be precursors to later health problems or indicators of early distress. This would help in understanding the respiratory health of deployed populations, particularly as one requirement for deployment is a high level of physical health. Cross-sectional designs widely used in military medical research do not allow for the documentation of sub-clinical changes, and, likewise, considering 'ill health'/clinical outcomes may miss these more subtle shifts in health.

The overall objective of this thesis is to understand how deployment may impact on respiratory health outcomes in military populations. This thesis begins by exploring the existing literature regarding both deployment-related environmental and psychological trauma exposures, and

how these could be associated with the respiratory health of Middle East Area of Operation (MEAO) deployed Service members.

The aim of this introduction is to provide the reader with the background literature and reasoning behind the assumption that there would be changes in both objective and subjective respiratory function and symptoms following deployment to the MEAO. Using a prospective design and a healthy deploying ADF cohort, allowed for investigation of the specific hypotheses that there would be a decline in objective and subjective respiratory function of ADF members from pre-to post-deployment to the MEAO and that deployment exposures may impact respiratory function in this cohort of ADF members. The findings from this thesis may apply to a wider international military population.

By investigating these topics in the context of previous literature, this thesis provides a deeper understanding of the importance of adverse respiratory outcomes, their relevance to deployment exposures and possible underlying mechanisms involved.

1.2 Background

During the last two decades, over 2.5 million United States (US) and coalition troops have deployed to Iraq and Afghanistan as part of global response to terrorism in the Middle East (1-3). In addition to combat injuries, the delayed health effects of operational service are of concern, particularly the psychological and physical effects of deployment exposures (4).

The importance of examining physical health concerns is highlighted by the consistent findings from post-deployment studies of personnel deployed in support of the First Gulf War (GW1) (1990-91) which involved increased reporting of all somatic symptoms, including respiratory symptoms, by GW1 veterans compared with non-Gulf War comparison groups (5-8). This

finding has been consistently replicated in a number of follow-up studies conducted many years after the end of the GW1 (3, 5, 6, 8, 9). This indicates that there may be some characteristics of deployment that are associated with adverse health outcomes.

The reasons underlying the adverse respiratory symptoms and conditions (e.g. shortness of breath, wheezing, coughing, asthma, chronic and acute bronchitis, and emphysema) documented among military personnel during and following deployment to the Middle East are not well understood (10-12). An important concern for veterans is that these symptoms may be indicative of the early onset of potentially serious debilitating diseases caused by environmental exposures, such as asthma, bronchitis and Chronic Obstructive Pulmonary Disease (COPD) (10, 13-15). Nonetheless, to date, in both the GW1 and the Iraq and Afghanistan conflicts, no specific association has been established between particular MEAO exposures and adverse respiratory outcomes, despite extensive epidemiological research (3, 8, 9, 16). Due to the limitations in standardising exposures, the cross-sectional, retrospective medical review, and self-reported nature of many studies, it is difficult to discriminate associations with specific deployment-related exposures and to reach a robust conclusion regarding the relationship between exposure and adverse respiratory outcomes. Therefore, before considering the potential role of exposures on health outcomes, determining if in fact there are deployment related changes to respiratory health outcomes still needs to be established. This can be realized by a prospective study design with specific data collection methods which has the advantage of being tailored to collect specific exposure data.

There are many characteristics of deployment that may be associated with adverse respiratory outcomes, including exposure to various airborne contaminants, burn pits, dust, particulate matter (PM), industrial fires and traumatic exposure (10, 13). In addition, evidence suggests that tobacco smoking, physical activities and other individual susceptibility factors such as age, sex, body mass index (BMI), blood pressure, physical fitness, pre-existing conditions and personal

characteristics may also increase the risk of respiratory symptoms and may enhance susceptibility to environmental exposures (11, 17-19). Some of these risk factors and how they affect respiratory function will be explained further later in this chapter.

Several international studies have documented an increased incidence of non-specific respiratory symptoms, asthma and constrictive bronchiolitis in deployed military personnel, with evidence that exposures while on deployment contribute to this via several pathways including physical destruction of respiratory tissues or distortion of the immune system (9, 11-13, 19).

In a review article by Korzeniewski et al. (2013), the authors concluded that military members deployed to the Middle East are at a particularly high risk of developing respiratory tract syndromes because of the stressful nature of their duties, the harsh environment, and exposure to novel pathogens during deployment. These psychological and physical factors may contribute to a broad spectrum of changes in the immune system and the occurrence of respiratory tract diseases in a military environment (11).

In a retrospective study by Abraham et al. (2014), the authors concluded that changes in behaviours during deployment (e.g. smoking tobacco), high particulate matter exposures, and high gaseous pollutant exposures among deployed personnel, relative to personnel stationed in the US, were plausible explanations for the higher prevalence of adverse respiratory outcomes (12).

In another retrospective study by Korzeniewski et al. (2013), the prevalence of respiratory diseases among Polish military members deployed to Iraq and Afghanistan was closely related to environmental factors, such as sand and dust storms, extreme temperature changes,

unsatisfactory sanitary conditions, and common disregard of basic principles concerning disease prevention (10).

Overall, the current literature suggests that an increase in adverse respiratory outcomes among military members following deployment may be associated with exposure to environmental factors (10-12, 20-25). In regard to adverse respiratory outcomes, exposure to psychological trauma has been less investigated than environmental exposures despite being highly prevalent among deployed military populations, and potentially being directly and indirectly related to impairment in respiratory function (10-12, 20-24, 26-30). The proposed mechanisms underpinning the effects of both environmental and psychological stressors may include similar effects via changes in immune function.

To begin, this thesis summarises the existing evidence regarding environmental and psychological trauma exposures, and other factors including physical activity, smoking, and individual susceptibility factors relevant to the military and deployed environment, and how these could be associated with the respiratory health of MEAO deployed military members.

1.3 Environmental exposures

Previous studies have indicated an association between deployment environmental exposures and adverse respiratory outcomes (10, 11, 18, 20, 24, 25, 31-36). Commonly experienced environmental exposures during deployment to the MEAO include air pollution (from local combustion sources, including burn pits, fire, fuel used in marine/aviation vehicles, natural gas and oil, bomb blasts and other explosions); sand and dust storms, and cigarette smoking (12, 13, 20-22, 37). Air pollution sources release smoke, gases and chemicals close to the ground, where they are easily inhaled and have been linked to neurological disorders, respiratory and heart diseases, and, in some cases, cancer (23).

Air sampling studies, conducted by US researchers suggest that multiple sources of air pollution including smoke from oil well fires, sand and dust storms, burn pit emissions, contribute to poor air quality in the deployed environment (21, 38). These findings are supported by independent work from investigators outside of the US (22), however, there is no data available from longitudinal research studies with objective pulmonary assessments comparing lung function between those deployed to the Middle East and non-deployed personnel. A review article by Falvo et al. (2015) summarised current knowledge about the impact of service and environmental exposures on respiratory health of military Service members deployed to Iraq and Afghanistan (39). The report reviewed 19 studies published from 2001 to 2014. While studies of environmental exposures, in particular airborne pollutants, have shown an association with an increased burden of acute respiratory symptoms, studies reporting chronic respiratory diseases do not provide conclusive results, mainly because of the non-representative sample of the study populations.

One of the key exposures identified in the GW1 Australian studies by Kelsall et al. (2004) was the smoke from oil wells (SMOIL) that were set alight by the Iraqi troops in Kuwait. This cross-sectional research was completed over 10 years after GW1, comparing 1456 Australian GW1 veterans with a randomly sampled military comparison group (n = 1588). Authors identified those who were exposed to SMOIL by inspecting the timing of a veteran's deployment which provided the likelihood of SMOIL exposure, as oil wells were set on fire after the air campaign had commenced on 17th of January 1991. Authors also reported that SMOIL was a reliably recalled exposure, assessed using kappa (k) as a measure of agreement over time in both UK (k=0.79) and US (k=0.69) Gulf War veterans. This suggests that recall bias would have had minimal impact on the reporting of SMOIL over time and on the association between reported SMOIL exposure and respiratory health outcomes (7).

In addition to SMOIL, there were also concerns about dust storms in the desert and exposure to burn pits (7, 40, 41). The study conducted by Kelsall et al. (2004) together with two other follow up Australian GW1 studies by the Monash Centre for Occupational and Environmental Health (2003) and Sims et al. (2015) which used the same sample of ADF deployed to the MEAO, showed no association between self-reported SMOIL exposure and overall objective lung function. The authors commented that despite an increase in self-reported respiratory symptoms, any effect of exposures such as SMOIL or dust storms were not reflected in the objective respiratory function of the population (7).

These findings suggest that environmental exposures did not (on this occasion) impact respiratory health and the self-reported impacts likely reflect somatisation. However, as the measures were cross-sectional, and there were no clinically meaningful associations, this does not answer the question of whether there were possibly changes in objective respiratory function, below clinical cut-offs (9). This is a gap in knowledge that the current thesis is able to address.

A study by Lange et al. (2002), 5 years after the GW1, examined a sample of 1896 US military members who served between August 1990 and July 1991 within the Gulf War theatre (i.e. Iraq, Kuwait, Saudi Arabia, Oman, Bahrain, Qatar, United Arab Emirates, the Persian Gulf, the Red Sea, and the Gulf of Oman). Approximately 94% of the study cohort were still in the gulf theatre during the time of the oil-well fires, and 21% remained there for more than 100 days during the fires. This study found an association between self-reported SMOIL exposure and asthma, chronic bronchitis and major depression (31). However, when using a more rigorous measure of modelled exposure (modelled exposures were exhaustively developed using a geographic information system to integrate spatial and temporal records of smoke concentrations with troop movements ascertained from global positioning systems records), no associations with health outcomes were identified. Thus, one explanation for the relationship

between self-reported smoke exposure and depression was that those meeting the case definition for major depression might have been prone to increased reporting of exposures and symptoms due to somatisation. The authors also speculated that associations observed between self-reported exposures and respiratory health outcomes may have been due to recall bias (i.e. unequal reporting of exposure between sick and healthy people). No examination or assumption was made regarding the link between respiratory symptoms and psychological exposures or major depression despite showing the association between SMOIL with both respiratory symptoms and major depression. Overall this study did not find a conclusive association, as it was only self-reported, with no objective measures of health outcomes. While the findings of studies that examined the effect of SMOIL exposure (7, 9, 40, 41), did not find convincing evidence of a long-term effect of SMOIL exposure in GW1 on respiratory health, the finding of an association between respiratory health and mental health (depression) by Lang et al raises the question of whether changes in respiratory symptoms may have been influenced by psychological factors as a confounder. As mentioned above, this association may occur due to changes to the immune system (9).

The limited available evidence suggests that exposure to dust or sand does not adversely affected the long-term respiratory health of GW1 veterans. In a US study by Petruccelli et al. (1999), among those who reported sandstorms to be their main perceived problem during deployment, there was no increase in prevalence of cough, wheeze or shortness of breath (42). None of the comparative studies, including Australian GW1 studies, in which spirometry was undertaken, showed any evidence that respiratory function was effected by deployment (7, 40, 41). This suggests that the exposures experienced in GW1 may not have been sufficient to produce objective evidence of respiratory disease. It is possible that any effects were sub-clinical, particularly given that these populations comprise individuals cleared as physically healthy to deploy. Therefore, it is important to investigate sub-clinical changes to health as an

indicator of reactivity/distress and potentially as a precursor to future emergence of health issues.

While no convincing evidence was found of exposures being associated with objective respiratory health, an overview of the long-term follow up studies examining the effect of GW1 deployment on respiratory health (i.e. irrespective of exposure to SMOIL or sand) did show an association between GW1 deployment and wheeze and/or diagnosis of asthma longer term: 10 years later in Australia (7, 8, 41), 7 years later in the UK (43), and 4-5 years later in the US (44). The Karlinsky study conducted 10 years after GW1 found no increase in self-reported asthma or chronic bronchitis, but a significant increase in self-reported wheeze (45). The fact that these results consistently find self-reported respiratory impacts but little or no evidence of objective declines suggests that factors other than deployment alone or environmental exposures are likely to contribute to the observed respiratory symptoms.

Despite inconsistent findings regarding environmental exposures and respiratory conditions among GW1 military personnel, studies of the Iraq and Afghanistan conflict since 2001 have provided more comprehensive evidence that exposure to airborne particulate matter in the deployed environment may explain some of the increased respiratory symptoms and conditions documented in military populations. The concerns and controversy regarding a possible association between environmental exposures and respiratory symptoms following GW1 was one of the reasons why there was such care put into the monitoring of respiratory health and exposures following the Iraq and Afghanistan conflicts.

Overall toxicological, epidemiological and clinical data are limited and prevent reliable evaluation of the prevalence or severity of adverse effects of environmental exposures in military personnel deployed to Iraq and Afghanistan. The current clinical evidence on the effect of deployment on respiratory health is primarily retrospective and does not provide clarity

regarding specific causative factors or the effect on the deployed population as a whole (39). Taken together, these findings suggest that environmental exposures including burn pits and air pollution may be associated with subjective health outcomes. Regardless of the source, it seems likely that higher levels of air pollution are common in many deployment areas and could contribute to future pulmonary and other health effects not yet identified (38).

A range of studies demonstrated evidence of environmental exposures and negative effects on respiratory outcomes. For example, in a descriptive case series by King et al. (2011), 49 US soldiers who returned from Iraq and Afghanistan with unexplained respiratory symptoms underwent extensive evaluation of their medical and exposure history, physical examination, pulmonary-function testing, high-resolution computed tomography and lung biopsy. Thirty-eight of these soldiers subsequently received diagnoses of constrictive bronchiolitis, an otherwise uncommon diagnosis, especially among a relatively young and otherwise healthy military population. The majority of biopsy samples showed polarisable material consistent with the inhalation of particulate matter (14). Therefore, it appears that exposure to airborne particulate matter in the deployed environment may explain some of the increased respiratory symptoms and conditions documented in the military. However, not all respiratory impacts are so specific.

Another US study reported that a majority of US Service personnel (94%) deployed to the MEAO as part of Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF) reported exposure to high levels of airborne pollution from a range of sources (24) that may have exceeded environmental, occupational, and military exposure guidelines (24, 46, 47). Given the nature of deployment exposures and known triggers for asthma, such as air pollution sources, deployed populations may be at risk of increased inflammation due to air pollution-inducing local respiratory reactions via the release of inflammatory mediators, which in turn may impact on respiratory function (12, 13, 20, 21, 28, 33, 48-51). A retrospective review of

medical diagnoses by Szema et al. (2010) reported that deployment to Iraq was associated with a higher risk of having a new International Classification of Diseases-9 (ICD-9) diagnosis of asthma post-deployment among US military personnel (34). This study showed that out of 6233 military personnel who served in Iraq or Afghanistan between 2004 and 2007 and were followed at the Northport Veterans Affairs Medical Centre, NY, 290 new-onset asthma cases were identified. Deployment to Iraq was associated with a significantly higher risk of asthma compared with stateside military personnel (6.6% versus 4.3%; with a crude odds ratio, 1.58; 95% CI, 1.18, 2.11). These associations persisted when stratified by gender and age group (34).

Asthma is a form of intermittent and reversible airway hypersensitivity. Increased airway hyper-reactivity in response to non-specific stimuli is a feature of asthma and, indeed, the diagnosis of asthma is often defined on the basis of the presence of such hyper-reactivity. In a US study of the causes underlying respiratory symptoms in military personnel returning from duty in Iraq and Afghanistan by Morris et al. (2013), 42% of US veterans reported non-specific respiratory symptoms that did not reach the threshold for a specific clinical diagnosis. The authors suggested that these sub-threshold issues of nonspecific airway hyper-reactivity may reflect development of a new airways disease, or aggravation of pre-existing conditions. The underlying mechanism of airway hyper-reactivity is thought to be hyper-activation of the immune system (36, 52). Similar findings were documented in occupationally exposed first responders to the World Trade Center (WTC) disaster (32, 35, 39).

In a longitudinal study by Banauch et al. (2003), rescue and recovery efforts after the WTC collapse resulted in the exposure of many individuals, including 14,000 NYC Fire Department rescue workers to respirable particulates and products of combustion. This study used a representative sample of 179 rescue workers stratified by exposure intensity (high, moderate, and control) without current smoking or prior respiratory disease (highly exposed workers arrived within 2 hours of collapse, moderately exposed workers arrived later on Days 1–2;

control subjects were not exposed). The study concluded that development and persistence of hyper-reactivity and reactive airways dysfunction at one, three, and six months post-collapse were strongly and independently associated with exposure intensity, i.e. the volume and type of exposure, size of particles, co-pollutants, climate variations, etc. (32). This suggests that even brief dust exposures can cause significant respiratory morbidity if the exposures are intense enough (34, 35). Although studies of GW1 regarding SMOIL and dust exposure (7, 31, 40, 42) also report increased respiratory symptoms, they were mainly descriptive or cross-sectional and detailed investigation of the intensity of exposures seems to be a common omission in these studies.

In addition to the environmental exposure intensity, psychological exposures may also play a role in the adversity of respiratory outcomes (9, 26, 27, 53). However, the impact of psychological trauma exposures as a confounder on the relationship between environmental exposures and adverse respiratory outcomes has not been thoroughly investigated in these studies.

The key consistent messages that come from the Iraq and Afghanistan military respiratory health studies include decline in respiratory function associated with environmental factors. Despite evidence of high levels of stress in this population and general links between psychological trauma and adverse respiratory outcomes, this has not been thoroughly investigated.

Synergistic effects among different environmental exposures and interactions between environmental exposures and stress or other influences are probable and deserve further study (9, 36). For example, stress may increase the individual's susceptibility to familiar or novel pathogens, such as those that may be first encountered on deployment (54, 55). Increased psychological stress could be the consequence of being in a deployed war zone or intense

combat training. Deployed environments can be mentally and physically demanding, involving not only prolonged periods of physical activity but also exposure to psychological stressors (11), sleep deprivation (11, 28, 56), shifts in daily rhythm, and exposure to thermal extremes (19, 57) and high- altitude environments (19, 21, 58, 59). The effects of such challenges on a soldier's health are complex and may result in a broad spectrum of changes in the immune system, which could, in turn, increase vulnerability to various diseases and respiratory tract infections (11).

1.4 Psychological trauma and stress

In addition to ambient airborne hazards, one of the factors unique to military service that may increase the vulnerability of military personnel to respiratory health risk is high levels of psychological stress (39, 53). There are a wide range of deployment-related stressors that may be considered psychologically traumatic. These include: being exposed to threatening situations; stressful events; vulnerable situations; witnessing killing death and violence; suicide; torture; and other atrocities.

Recently, a number of studies have found positive associations between psychosocial stress and respiratory symptoms (28, 34-36, 47, 53), suggesting that, in the specific context of military service and deployment, in addition to the established risk of environmental exposures, the psychological stress of deployment should be considered as an important contributing factor.

There is growing evidence for an association between exposure to psychological traumatic stress, such as combat experience, and respiratory symptoms and conditions, including shortness of breath, asthma, chronic bronchiolitis and COPD (29, 30, 53, 60, 61). This relationship has also been demonstrated in adult research populations exposed to the September 11, 2001 WTC terrorist attack. More specifically, moderate associations between post-traumatic

stress disorder (PTSD) and respiratory symptoms have been observed in first responders to the WTC (14, 32, 60, 62). However, while dust exposures would be a more likely cause of adverse respiratory health outcomes observed in this cohort, the combined effect of the psychological trauma of the situation on objective respiratory function has not been thoroughly investigated (9).

With respect to biological mechanisms, PTSD is characterised by changes in the hypothalamic–pituitary–adrenal axis and the sympathetic–adrenal–medullary system (63). It has been suggested that these alterations can lead to a pro-inflammatory state (64-67), and in fact may also be implicated in the aetiology of PTSD and other disorders. Thus, inflammation is a common link between trauma exposure and both PTSD and airflow limitation, which itself is associated with inflammatory processes (60, 68).

A cross-sectional study by Spitzer et al. (2011) provides evidence for this association between PTSD and respiratory function (60). This study examined the associations between self-reported respiratory symptoms, objective lung function, trauma exposure, and PTSD in 1,772 civilian adults randomly selected from a sample population based in north-eastern Germany. This study used standardised questions and spirometry testing. Of the 1,772 community residents included in this study, 915 (51.6%) subjects had been exposed to at least one traumatic event and 28 participants met criteria for PTSD (1.6% of the total study population and 3.6% of those with trauma exposure). Those with a diagnosis of PTSD had a significantly greater risk of having asthma symptoms than those without PTSD. However, those with a history of psychological trauma, but not a diagnosis of PTSD, did not have an elevated risk, suggesting that this association is specific to disorder status rather than symptomatology or trauma exposure per se. Analyses indicated that subjects with diagnosed PTSD had a significantly increased risk for airflow limitation independent of its definition. The authors suggested that inflammation may be the link between trauma exposure, PTSD and air flow limitation. While the findings inform

relationships between trauma exposures and adverse respiratory outcomes, there are several limitations in cross-sectional studies mainly in terms of their reliability and validity. Due to the cross-sectional nature of this study, the reported associations do not allow any causal inferences as the temporal relationship of self-reported respiratory symptoms and respiratory function findings relative to psychological trauma exposure and PTSD onset was not available (60). Using a prospective design could have further confirmed these associations.

The prevalence rate for PTSD in deployed military members varies widely, ranging from 2% to 35% (69), with such discrepant findings at least partly influenced by factors, such as measurement methods, and sample characteristics, such as service role (70, 71). In particular, the role of PTSD in adverse respiratory outcomes is uncertain in the military population. With the current indication of links between trauma exposures, PTSD and adverse respiratory outcomes, it is important to investigate these relationships as the prevalence of such disorders are high within the military populations.

As the available evidence suggests that both environmental and psychological exposures during deployment could be associated effect respiratory health outcomes, more comprehensive prospective studies are needed to further clarify the association between environmental exposures, psychological trauma, PTSD and adverse respiratory outcomes in the military population.

In addition to deployment-specific exposure risks, evidence also suggests other factors such as physical activity, (72) increased tobacco use (18, 73) and other individual susceptibility factors (74) may increase the risk of respiratory symptoms and enhance susceptibility to environmental and trauma exposures in this population (58, 75, 76).

1.5 Physical activity

Researchers have suggested that physical activity performed in stressful environments, such as during military training, may alter immune function and can be a contributing factor to suboptimal neurologic and overall long-term health (28, 72). Light physical activity or moderate environmental stress stimulates immune responses, but exhausting physical activity or severe environmental stress can have immune suppressant effects, manifested by a temporary increase in susceptibility to respiratory infections (19). Multiple physical and psychological stressors, such as those encountered on deployment, may induce alterations in immune parameters and/or neurological and endocrine responses; these common exertion-induced pathways could result in respiratory tract syndromes (11). For example, there is evidence that vaccination seroconversion rates are decreased when the vaccinations are given during extensive military training before deployment (77, 78). This is biologically significant for the deployed population because it could result in sub-optimal immunity against several antiviral/bacterial vaccines, including influenza vaccine, and hence result in increased reported respiratory symptoms and conditions which have been recently found in military studies (77, 78).

1.6 Smoking

Cigarette smoking is a well-established carcinogen and, as well as causing non –malignant respiratory diseases (COPD, emphysema, chronic bronchitis, and asthma), there is clear evidence linking it to both morbidity and mortality (10, 13, 39, 54, 75, 79). Pathological mechanisms of smoking, including immune changes, and its adverse health effects, such as asthma, bronchitis and COPD, generally overlap with environmental air pollution (73, 75). Smoking has also been related to increased susceptibility to respiratory insult from airborne hazards (75). Smoking is a major risk factor for acute respiratory tract syndrome and other systemic infections; active and passive smoke exposure increases the risk of infection (80). The mechanisms by which smoking increase risk are multifactorial and include structural and

immunologic alterations (81). Smoking suppresses immune responses and impairs host defences, e.g. by exhausting the removal of contaminants from the respiratory tract (82). It also produces a chronic inflammatory state, including chronic bronchitis and aggravation of asthma. Smokers are also more likely to become ill with and die from influenza and bacterial pneumonia (81).

Since the 1960s, the rate of tobacco smoking has declined in the US, including in the military (73). However, the rate of tobacco smoking among active duty military personnel remains higher (32%) compared to the general population (~20%) (73). Within the US military population, the prevalence of smoking is approximately 40% higher among veterans (22%) (a veterans is defined as "a person who served in the active military, naval, or air service and who was discharged or released under conditions other than dishonourable") and 50% higher among deployed military personnel compared with their non-deployed counterparts (73). In a cross-sectional study by Sanders et al. (2005), it was reported that 47.6% of US military personnel deployed to Iraq and Afghanistan began or resumed smoking while deployed (54). High rates of tobacco smoking are not restricted to US military personnel; the rates are also increased by 40%–60% among coalition militaries (83).

Although cigarettes are sold excise free to ADF personnel through Frontline Defence Services and unit canteens during deployment, smoking in all Defence establishments has been banned for several years. This policy also applies to contractors and visitors. In addition, while ADF members are still able to smoke outside Defence establishments, smoking is actively discouraged and ADF members receive financial and therapeutic support if they undertake 'Quit' programs during and after deployment (84, 85). Similar smoking restrictions and policies were put in place for the US military in 1997 when the use of tobacco was banned during basic training, along with an increase in the number of designated non-smoking areas, and a prohibition on health care providers smoking on duty (86, 87). However, despite these attempts,

decades of the tobacco industry lobbying and targeting the US military has driven smoking rates significantly higher among service members than the rest of the population (32% vs 20% respectively) (86, 87). In 2010–2011, the MEAO Census Study found that smoking was more prevalent among 18- to 24-year-old men (34%) and women (29%) than among the same sex/age groups in the Australian population (24% and 22%, respectively) (3, 88). In addition, 38% of respondents reported smoking more than usual during deployment, and 17% reporting beginning or re-starting smoking (88).

Findings from a prospective study of Australian military personnel deployed to the MEAO (the same sample used in the current thesis) showed that those respondents who began or resumed smoking while on deployment were also likely to have more psychological co-morbidities compared to those who did not smoke on deployment. Comorbidities were defined as having one, two or three psychological conditions including alcohol disorder, anxiety disorder, or affective disorder, including depression and anxiety (3). Similarly, those who smoked more than usual were likely to have more co-morbidities compared to those who did not smoke (3). Nevertheless, in the MEAO prospective report (2012) the relative impact of different exposures and other non-smoking related risks were not examined in this population. This will be further examined in the current thesis.

While specific factors contributing to smoking rates have not been ascertained, the significant smoking uptake among deployed military members observed in a number of studies is thought to relate to deployment stress, particularly among those with prolonged deployments, or combat exposures (73). Combat exposure, military stressors and PTSD have all been identified as predictors for cigarette smoking (74, 75). As discussed above, these same psychological risk factors and mental health disorder have also been associated with respiratory symptoms, abnormal lung function and conditions such as asthma (53, 75). Although tobacco smoke may differ in many respects from the ambient air pollution in deployed settings, the contribution of

tobacco smoke exposure to the cumulative exposures to airborne hazards experienced by military personnel while on deployment cannot be excluded as a potential contributing factor, given the prevalence and intensity of tobacco use in stressful combat situations (41). The potential for smoking to interact with and/or exacerbate other environmental or stress exposures is of importance to examine. However, there is currently insufficient information or standardisation of data (e.g. type and intensity of environmental exposures, number of cigarettes smoked per day, etc.). Since the MEAO prospective study which analysed the same sample of ADF members as the current thesis, showed no significant association between smoking status or smoking behaviour and change in FEV1/FVC (the FEV1/FVC ratio which represents the proportion of a person's vital capacity that they are able to expire in the first second of forced expiration to the full, forced vital capacity), this thesis did not focus on what was found previously, and cigarette smoking was included as one of the environmental exposures and analyses were adjusted for cigarette smoking where appropriate.

1.7 Individual susceptibility factors

In addition to the environmental and psychological factors that may affect respiratory health of military members, individual susceptibility factors such as age, sex, BMI, blood pressure, physical fitness, pre-existing conditions and personal characteristics may also play a role in adverse respiratory outcomes.

In a case control study of active duty and retired US military members, increasing BMI, younger age, gender, non-active duty beneficiary status, and arthritis were significant independent predictors of asthma in this population (89). Similarly, Abraham et al. (2012) reported that gender, and serving in the army remained independent predictors of having a new obstructive pulmonary disease encounter (90). Age and combat occupations were not associated with the likelihood of a post-deployment obstructive pulmonary disease diagnosis. The fact that

combat occupations would be likely to have the highest level of traumatic deployment exposures makes this finding relevant to the argument of this thesis. i.e., this would suggest that perhaps environmental exposures are not relevant to more severe respiratory problems, at least in the short term. This aligns with the GW findings concerning environmental exposures not being associated with clinically significant impairment in lung function.

In a cross-sectional study, data collected from a European Community Respiratory Health survey of 16 countries were examined. The aim of this study was to estimate the age and sex-specific incidence of asthma from birth to the age of 44 in men and women across several countries. This study demonstrated that there are different patterns of asthma incidence in men and women. During childhood, girls had a significantly lower risk of developing asthma than boys. Around puberty, the risk was almost equal in the two sexes, while after puberty, the risk in women was significantly higher than that in men (77). While the sample is not comparable to the military population (i.e. military members are generally younger, healthy male etc.) the findings inform the possibility of age and sex as factors influencing respiratory outcomes.

Studies regarding the association between respiratory health conditions and individual factors in the population and deployed military personnel generally focus on single respiratory outcomes and are usually assessed using different methods, e.g. using medical record reviews that are predominantly retrospective (10, 12, 34), and are therefore also subject to potential biases (reflected in documentation and health care seeking).

The way in which the above-mentioned factors might interact with deployment exposures to influence respiratory health outcomes has not been thoroughly studied. This deserves further attention in larger epidemiological studies, particularly given emerging evidence of their influence on physical and psychological health (10, 14, 29, 43, 49, 66, 67, 79, 83, 88, 91).

Although most studies reviewed in this chapter are from the US, Australian troops have also been actively involved in GW1, Iraq and Afghanistan conflicts and shared bases and geographical location. Given the average deployment lengths are similar between both militaries (5-18 months) and assuming the exposure risks were similar, ADF members may be at similar risk to US military personnel (38, 92-94).

1.8 Immune response

Previous studies suggest that the potential underlying mechanisms for association between environmental/ psychological trauma exposures and adverse respiratory health outcomes may involve alteration in the immune system (9, 11, 19, 28). The following paragraphs will discuss the possible changes in the immune system as a result of environmental and psychological stress and how they may influence respiratory outcomes.

The immune system protects the host from pathogens and helps eliminate toxic or allergenic substances that enter through mucosal surfaces. There are two types of immune responses, innate and adaptive. The innate immune response is non-specific. It consists of cells and proteins that are always present and ready to mobilise and fight offending bodies at the site of infection. The main component of the innate immune system includes surface barriers (skin and mucous membrane) and internal defenses (phagocytes, dendritic cells, Natural Killer (NK) cells, antimicrobial proteins, fever and inflammation). The adaptive immune system, on the other hand, is called into action against pathogens that are able to evade or overcome the innate immune defense. It is directed at specific targets and is systemic. After initial exposure and activation, a more rapid response is made to subsequent exposures to pathogens. There are two types of adaptive immune responses: humoral immunity, mediated by antibodies produced by B lymphocytes, and cell-mediated immunity, mediated by T lymphocytes (95).

Inflammation is the body's way of signaling the immune system to repair damaged tissue, as well as protect the body against foreign invaders, such as harmful pathogens. Inflammation is mostly considered as a mechanism of innate immunity that can be triggered by a variety of factors, including pathogens, damaged cells, toxic compounds, irritation and stress. These factors may induce acute and/or chronic inflammatory responses in different organs of the body (96, 97). Acute inflammation is a quick response of the body to tissue injury, usually appearing within minutes or hours. It is characterised by five cardinal signs: redness, immobility, pain, swelling and heat (96-98).

Usually, during acute inflammatory responses, cellular and molecular events and interactions efficiently minimise impending injury. This mitigation process contributes to restoration of tissue homeostasis and resolution of the acute inflammation. Chronic inflammation happens when this response lingers, leaving the body in a constant state of alert and potentially leading to tissue damage or disease (96, 99).

Several studies have shown that, in addition to direct particulate or chemical effects, air pollution induces local respiratory and systemic immune reactions via the release of inflammatory mediators (9, 33, 48-51, 100-105). Therefore, potential connections between an increase in environmental exposures and adverse respiratory health outcomes may partly be explained by alteration in levels of inflammatory mediators, such as cytokines, via structural and functional respiratory changes (54, 101, 106-111).

Regarding environmental exposures, the mechanism that initiates the local and systemic inflammation is believed to involve stimulation of epithelial cells and alveolar macrophages by particulate matter. Alveolar macrophages play a key role between the inflammatory processes in the lung and the systemic response because they are the cells responsible for ingesting and clearing inhaled particles (112). The interaction of alveolar macrophages with particulate matter

increases their phagocytic activity (i.e. ingesting other cells or particles), oxidant production, and the release of inflammatory mediators such as cytokines, chemokines, proteases and eicosanoids that then elicit both local and systemic inflammatory responses (103, 104, 109, 113, 114). These substances play a role in recruiting inflammatory cells such as neutrophils, monocytes, mast cells and eosinophils to the lung (115, 116). Interactions between macrophages and epithelial cells enhance these responses. Repeated exposures and increases in lung inflammation cause tissue destruction and may reduce lung function in the long term (33, 115, 116).

The systemic inflammatory response is characterised by activation and mobilisation of inflammatory cells (116-118), the production of acute-phase proteins and the production of circulating inflammatory mediators (119). An integral component of this response is stimulation of the hematopoietic system, specifically, the bone marrow resulting in a temporary increase in circulating leukocytes. Several large population-based studies have shown that a persistent high level of leukocytosis is a predictor of total mortality, independent of smoking (113, 120). Military personnel exposed to high concentrations of particulate matter air pollution during the forest fires in Southeast Asia in 1997 developed leucocytosis, that was associated with hyper-stimulated bone marrow (121).

In general, PM exposure may alter respiratory function by a variety of different mechanisms. Potential pathways for the effects of PM on the respiratory system include: airway remodelling, allergic disorders, impaired host defence and infection, progression of pre-existing lung disease and DNA damage. In the short-term, airway hyper-responsiveness may ensue due to the influence of inflammatory mediators. In the long-term, morphological changes may occur, in some cases leading to mucus hypersecretion and airway remodelling.

1.8.1 Immune response to psychological trauma exposures

While a number of studies have provided general evidence of a link between stressful psychological exposures and negative respiratory outcomes (28, 34, 36, 39, 47, 53, 54), the uncertainty about the association is complicated by the relative lack of data regarding the underlying mechanisms.

One possible mechanism underpinning the association between stress and reduced respiratory function could be increased levels of systemic inflammatory mediators (53, 107, 108, 111, 113). Excessive pro-inflammatory responses may cause airway damage and consequently structural and functional pulmonary changes (54). Hypothetically, higher levels of stress during deployment among personnel may in part explain the increased rate of respiratory symptoms reported in recent studies. There is increasing evidence of associations between stress related mental disorders and altered immune responses, and elevated circulating inflammation. However, the direction of this association is not conclusive (53, 66, 107, 108, 113). Regardless, low level inflammation and altered immune response provides plausible mechanisms by which trauma exposure may be associated with respiratory symptoms (53, 60, 107, 108, 111, 113).

The rapidly emerging field of neuro-immunology has shown evidence of associations between low-level inflammation and psychological symptoms, with evidence of bi-directional effects. Reported effects of psychological symptoms on inflammation or vice versa were mainly described in terms of psychological disorders, including PTSD (122, 123). PTSD is mainly characterised by persistent hyperarousal, autonomic dysregulation and elevated heart rate. Similar to PTSD, panic disorder (PD) is also an anxiety disorder with prominent psychophysiological symptoms, including respiratory abnormalities (123-125).

The general mechanism of imbalance in biological homeostasis as a result of traumatic psychological exposures in humans involves the sympathetic nervous system and the

hypothalamic-pituitary-adrenal axis (HPA), which has been shown to mediate the physiological response of the body to psychological stress via entering a state of hypervigilance. This forms the foundation of the metabolic response to trauma exposure. In PTSD, the state of hypervigilance is known to maintain abnormal HPA function (124, 126, 127).

A mechanism of interest is sensitisation, a process where individuals who are repeatedly exposed to a risk factor may develop progressively greater responses over time, resulting in a lasting change in response amplitude. Heim and Nemeroff (1999) described how the process of sensitisation, arising from multiple trauma exposures, is supported at a biological level. The core underlying biological systems that are often involved include inflammatory mediators such as Interleukin 1 beta (IL-1β), Interleukin 6 (IL-6), Tumour Necrosis Factor – alpha (TNF-α), and C Reactive Protein (CRP) (127). Evidence is beginning to emerge showing that circulating inflammatory mediators respond to acute psychological stress. However, research published to date has varied greatly in the composition of study groups, the timing of samples, methods, and the type of challenge imposed. Therefore, the potential underlying mechanisms of stress, increased levels of circulating inflammatory mediators and negative respiratory health outcomes, remain an area that needs further investigation (53, 54, 101, 106, 107, 109, 111, 128, 129).

High levels of inflammation as a result of psychological stress have been shown to lead to greater susceptibility to risk factors such as environmental exposures. In a study by Clougherty et al. (2010) a double-exposure paradigm was used, where rats were subjected to social stress and concurrent exposure to particulate matter air pollution. Compared with non-stressed controls, exposed rats demonstrated altered breathing patterns (i.e. rapid and shallow) and a systemic inflammatory response (e.g. elevated CRP, TNF-α and white blood cells) consistent with adverse respiratory outcomes. Although in humans additional studies are needed to further elucidate these pathways, an inflammatory-mediated mechanism for enhanced susceptibility to

air pollution is tenable (76). It is important to understand that the cumulative impact of deployment exposures and subsequent minor symptoms and objective indications, may tip over at some point into clinically significant symptoms or probable disorders. Identifying markers of risk in still healthy individuals allows for mitigation strategies aimed at ultimately preventing poor health trajectories.

Adverse respiratory outcomes in military personnel, linked with deployment exposures, would highlight the need for a risk management approach to the deployment environment. Risk management strategies could focus on reducing exposures, ensuring recovery, and increasing resilience to these risk contributors to minimise adverse respiratory outcomes in vulnerable military personnel.

1.9 Limitations

A number of studies in this review were of cross-sectional design; consequently, any respiratory health issues in existence before an exposure were not accounted for. Without baseline data, it is not possible to accurately assess the impact of specific deployment exposures on an individual's respiratory health. Cross-sectional studies are carried out at one period and do not indicate the series of events. Therefore, it is difficult to determine the relationship between exposure and outcome as they lack the time element. In addition, without baseline data, subclinical changes are difficult to identify. The issue of subclinical symptoms in otherwise healthy populations is of importance, particularly when deploying military populations are largely healthy.

Previous studies have largely relied on self-report data to measure the impact of exposures on respiratory health. This type of measurement is open to recall bias, particularly when data is collected well after exposures have occurred. In addition, it is also difficult to standardise the

reported symptoms, for example, what one person might consider ‘shortness of breath’, another person might regard as normal (54, 106). These could limit the reliability and validity of findings. Using a prospective design and objective measures could minimise the recall errors as well as determining the baseline health status before exposure or condition events occur. In addition, medical record reviews are predominantly retrospective (10, 12, 34) and therefore also subject to potential biases (reflected in documentation and health care seeking).

1.10 Conclusion

The objective of this literature review was to summarise the key respiratory health concerns and exposures in the military population. It also summarises the underlying biological mechanisms that may be involved in adverse respiratory health outcomes reported in this population. The information in the background and introduction was used for a published systematic review (See last section of this thesis under Publication).

Current evidence indicates that deployment-related environment, combat and other exposures, and psychological trauma more generally, may be associated with adverse respiratory outcomes and other health effects not yet identified. These associations may be via direct actions (local effects such as deposition of particulate matter) or initiation of pulmonary inflammation systematically due to psychological factors and disturbance of the immune system. It is particularly important to further investigate the role of psychological trauma and its association with respiratory manifestation as psychological stress, while highly prevalent in relation to deployment, is a less investigated risk factor for respiratory health outcomes. Further, the potential mechanisms underlying associations, as well as potential predictors of good or adverse respiratory health over time, are not well understood (61, 129, 130).

1.11 Thesis hypothesis, aims and questions

1.11.1 Hypotheses

In light of findings from the existing literature, it was hypothesised that there would be an observable decline in both objective and subjective respiratory function of contemporary ADF members from pre-to post-deployment to MEAO between 2010 and 2012. Further, it was also postulated that environmental and psychological trauma exposures would independently and combined contribute to changes in self-reported respiratory symptoms and objective respiratory measures in this cohort of ADF members.

1.11.2 Aims

The aims of this thesis are:

1) To investigate if, similar to the reported international literature, there is an increase in subjective respiratory symptoms (self-reported respiratory symptom measured by questionnaire) of ADF members from pre- to post-deployment to the MEAO between 2010 and 2012 and whether these are accompanied by any changes in objective function (FEV1/FVC measured by spirometry), possibly at a sub-clinical level. (Chapter 3 presents and discusses this topic).

2) To examine the predictors of adverse respiratory outcomes among this cohort in the context of combat environmental and psychological trauma exposures (Chapter 4 provides detailed investigation of predictors of adverse respiratory outcomes).

1.11.3 Research questions

The specific questions that will be addressed in the following chapters include:

1. Is there a change in respiratory function among ADF personnel deployed to the MEAO between 2010 and 2012 from pre-to post-deployment?
2. What are the impacts of deployment exposures on respiratory outcomes of

ADF members deployed to the MEAO between 2010 and 2012?

The overall objective of this thesis was to understand how deployment may impact on respiratory health outcomes in military populations.

A major outcome of this study was to identify if psychological trauma exposures are associated with negative respiratory health outcomes in the short-term following deployment to the MEAO. This was the first Australian prospective study to investigate the effect of psychological trauma exposures on respiratory health outcomes and whether psychological responses to deployment exposures moderate the association between environmental exposures and respiratory health outcomes.

By investigating these topics in the context of previous literature, this thesis provides a deeper insight into the importance of adverse respiratory outcomes, their relevance to deployment exposures, and the possible underlying mechanism involved.

Chapter 2 – Samples and Methodology

2.1 Introduction

The previous chapter summarised the key respiratory health concerns and exposures in the military population. It also summarised the underlying biological mechanisms that may be involved in adverse respiratory health outcomes reported in this population.

In light of findings from the existing literature, this study tested the hypothesis that there would be an observable decline in objective and subjective respiratory function of contemporary ADF members from pre-to post-deployment to MEAO between 2010 and 2012. Further, it is also postulated that environmental and psychological trauma exposures (independently and combined) may impact self-reported respiratory symptoms and objective respiratory measures in this cohort of ADF members. This chapter will describe the methodology used to answer the specific study questions in the next two chapters:

1. Is there a change in respiratory function among ADF personnel deployed to the MEAO between 2010 and 2012 from pre-to post-deployment?
2. What are the impacts of deployment exposures on respiratory outcomes of ADF members deployed to the MEAO between 2010 and 2012?

To the author's knowledge this was the first Australian perspective study to investigate the effect of psychological trauma exposures on respiratory health outcomes and whether psychological responses to deployment exposures moderate the association between environmental exposures and respiratory health outcomes. By investigating these topics in the context of previous literature, this thesis provides profound understanding regarding the importance of respiratory health in deployed populations, how various types of deployment exposures contribute to this, and the possible underlying mechanisms involved. Beyond the military context, it will contribute to understanding of the relationship between stress and

trauma, and physical and mental health in general, including the mechanisms by which exposure to stressors may lead to poor respiratory health outcomes over time.

The following chapter provides a detailed summary of parts of the MEAO Prospective Study dataset utilised in this thesis. Details pertaining to research hypotheses and statistical analyses, including a description of the final sample and measures used for analysis, are also outlined. The detailed data analyses for each chapter are discussed in the methodology section of the corresponding chapter.

2.2 Middle East Area of Operations prospective study

The MEAO prospective study was commissioned by the Australian Department of Defence, and undertaken by the Centre for Traumatic Stress Studies, University of Adelaide, between 2010 and 2012, in order to provide insight into the impact of deployment and combat exposures in the MEAO on the health of ADF members (3). The MEAO prospective study, together with the 2010 ADF Mental Health Prevalence and Wellbeing Study (131) and the MEAO Census Study (88), formed part of a series of health studies funded by Australian Defence which were collectively referred to as the Military Health Outcomes Program (MilHOP). MilHOP was conducted to examine the physical and mental health of all ADF members. It was designed to add to the growing body of knowledge that has already been collected under the Deployment Health Surveillance Program (3, 71, 88) and to overcome many of the challenges faced by other health studies conducted by Australia and its coalition partners. These challenges include:

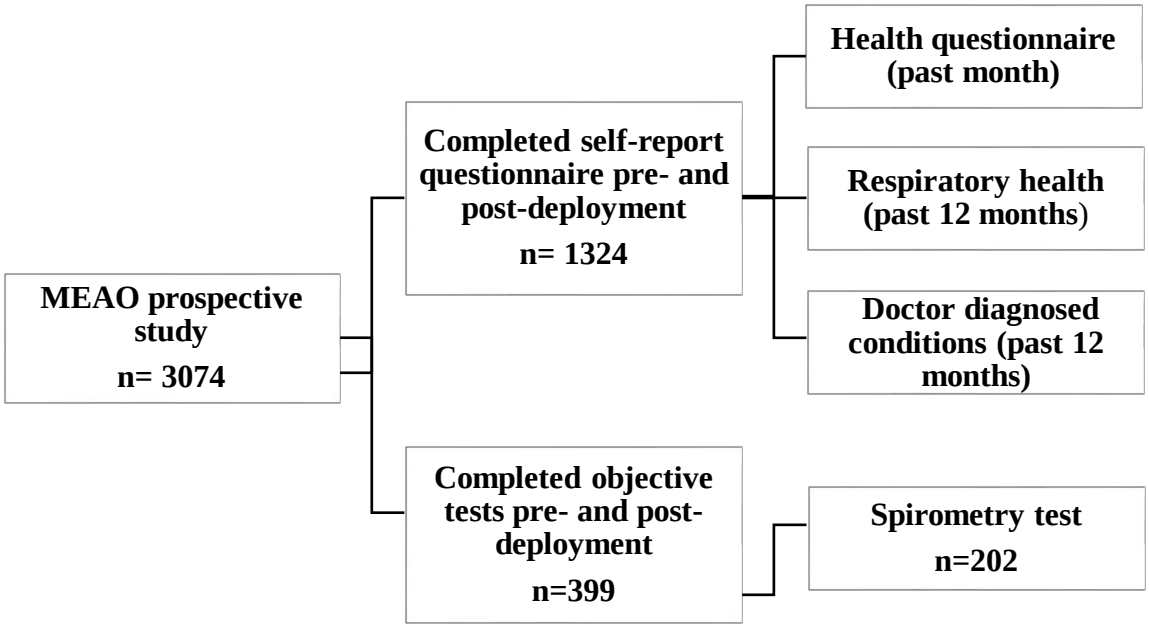
- the ability to control for exposures and risk factors that exist prior and during deployment; collection of objective as well as self-report health measures; and
- collection of information about hazards and exposures in close temporal proximity to the end of deployment (3).

This thesis utilises data drawn from the MEAO prospective study and focuses on factors associated with respiratory health outcomes among a sample of ADF members deployed to the MEAO.

Many previous studies into health effects of deployment have been prompted by reports of ill-defined self-reported symptoms that were attributed to service in the area of operations, but were without a clear causal or diagnostic link (which was subsequently known as First Gulf War Syndrome) (5, 6, 132). The MEAO prospective study focused on a range of potential health outcomes of direct relevance to the nature of the deployment, including those identified by the Institute of Medicine (e.g. neurocognitive and neurobehavioral effects, hypertension and chronic respiratory effects etc) (93). The MEAO prospective study is the only prospective health study involving ADF members. Both objective and self-reported data were collected on a range of physical, biological, psychological and social health outcomes (only a small cohort of the larger MEAO completed the objective health data). In order to ensure that any changes in health outcomes could be attributed to deployment to the MEAO, this study assessed a subset of individuals prior to deployment and again on their return to Australia (approximately 1 month prior to deployment, and again approximately 4 months after return) (3, 133). This design provides a unique opportunity to gain more insight on the short-term impacts of deployment-related exposures on the respiratory health of ADF members. To date, there has been very limited analysis of the respiratory health outcomes of ADF members following deployment. However, initial findings from the GW1 and MEAO prospective studies indicated increases in self-reported respiratory symptoms (7, 9), as well as possible negative shifts in objective measures of respiratory function following deployment to the MEAO (3, 88).

The data used in the current study included objective (spirometry test) and subjective (self-reported questionnaire) measures. These data were used to address how different deployment exposures might affect the respiratory outcomes of MEAO deployed ADF members.

Figure 2.2 Data used in this study



Data approval was provided by the Military and Veterans' Health Research Data Access Committee (MVHRDAC) for the current study.

2.3 Sample

All ADF members (n=3074) who deployed to the MEAO after June 2010 and returned from that deployment by June 2012 received a survey regardless of: service (Navy, Army or Air Force); rank; gender; length of deployment; country where most time would be spent (i.e. the person could have been in Afghanistan or in an area/country outside Australia supporting these operations); role (combat, support, technical, etc); and/or whether the ADF member had previously deployed to the MEAO. Out of the total number of ADF members deployed, 1324 individuals completed the questionnaire component (3).

To be invited to participate in the physical testing (including height, weight, waist and hip circumference recording, blood pressure testing, lung function spirometry testing, and

cardiovascular fitness assessment), individuals must have been eligible to participate in the questionnaire component (as listed above), and be assigned to one of the following: A Navy ship; either of the two Special Forces Commando Units (1CDR and 2CDR); either of the two Special Forces Special Air Services (SAS) Units (1SAS and 2SAS); either of the two Army Mentoring Task Force Units (MTF2 and MTF3); or Army Force Communications Unit (1FCU) (3). This subsample was selected on the basis of being in primarily combat roles, thus having a greater likelihood of exposures.

Due to the extensive training commitments and short lead-up time associated with many deployments, not all personnel could participate. Prior to deployment, 1871 ADF members (60.9% of all deployed) participated in the MEAO study. Of these, 1324 (70.8% retention rate) also participated within 4 months following their return from deployment (134). As the research presented in this thesis is related to deployment-specific respiratory health outcomes of ADF members, data from only those who completed both pre- and post-deployment spirometry tests and self-reported questionnaire components were filtered and included in the final analysis.

The MEAO study population had been deemed mentally and physically fit to deploy (12) .The table below shows the demographic and service characteristics of the MEAO prospective study population.

Table 2.3.1 - Demographic and service characteristics of the entire MEAO prospective study sample who were deployed to the MEAO between 2010 and 2012 (n total=3074)

Characteristics	Sub-group	Population number
Total sample		3074
Age	16-24	1074
	25-34	1270
	35-44	543
	45-54	160
Sex	Female	250
	Male	2824
Service	Army	2289
	Navy	233
	Airforce	552

Of the total sample, 399 participants completed the physical test both pre- and/or post-deployment. Of the 399, 197 were excluded due to the fact that they did not complete the spirometry test at both pre- and post-deployment, or they did not meet the criteria of 2005 American Thoracic Society (ATS) and European Respiratory Society (ERS) (which includes a statement on the standardisation of spirometry) for valid spirometry (3, 135-137). The following are numbers of excluded participants and the reasoning behind exclusion from the final analysis.

- 53 participants did not complete spirometry at pre-deployment.
- 22 did not complete spirometry at post-deployment.
- 5 physical testing participants did not complete spirometry at both pre- and post-deployment.
- 50 pre-deployment, 27 post-deployment and 40 pre- and post-deployment tests were

completed, but upon review by the Professor of Clinical Respiratory Physiology at the University of South Australia, they were deemed not to meet the American Thoracic Society and European Respiratory Society (ATS/ERS) 2005 criteria (135) for valid spirometry, and were therefore excluded from the analyses (3). For valid spirometry, participants had to produce 3 acceptable (i.e. deep enough inspiration without hesitant or cough with maximum effort and long enough exhalation) and 2 reproducible tests (i.e. result must have been reproducible after maximum of 8 attempts according to the ATS/ERS guideline).

The remaining 202 participants with complete reliable data were eligible for analysis, having completed both pre- and post-deployment spirometry tests and meeting the ATS/ERS criteria.

The following table is a summary of demographic and service characteristics of responders included in the final analysis.

Table 2.3.2 – Demographic and service characteristics of responders who completed both pre- and post-deployment spirometry and self-reported questionnaire and were in combat role (n total=202)

Characteristics	Sub-groups	N pre-post deployment
Total		202
Age	16-24	86
	25-34	86
	35-44	26
	45-54	4
Sex	Female	3
	Male	175
	Missing	24
Service	Army	192
	Navy	10
Prior deployment	No prior dep	54
	1-2 prior dep	75
	3-4 prior dep	25
	4+ prior dep	16
	Missing number of prior deployment	32
Current smoking	Yes	85
	No	103
	Missing	14

Table 2.3.3 – Demographic and service characteristics of responders who completed both pre- and post-deployment spirometry and self-reported questionnaire and were excluded pre- or post-deployment (n total=192)

Characteristics	Sub-groups	Number of excluded participants with complete spirometry and self-reported questionnaire pre- and post-deployment
Total		192
Age	16-24	91
	25-34	83
	35-44	14
	45-54	4
Sex	Female	3
	Male	173
	Missing	16
Service	Army	183
	Navy	9
Prior deployment	No prior dep	41
	1-2 prior dep	70
	3-4 prior dep	24
	4+ prior dep	24
	Missing number of prior deployment	33
Current smoking	Yes	69
	No	103
	Missing	20

Note: Out of 399 physical testing participants, 5 did not complete spirometry at both pre- and post-deployment, and therefore were not included in total sample in this table.

2.4 Measures

Self-reported measures

Self-report questionnaires were designed to collect measures of physical and psychological health and deployment experiences. The pre-deployment questionnaire (Appendix 2.1) covered participants' deployment history, their pre-deployment health status, including physical, psychological, social function, and health risk factors. Information was then gathered on individual factors of personality and prior life experiences that could contribute to each particular health outcome.

The post-deployment questionnaire (Appendix 2.2) covered post-deployment health status, including physical and psychological health, social function and risk factors since the beginning of their last deployment. Recent deployment experiences were covered to capture the health risk factors and threats that occurred in relation to their latest deployment to the MEAO.

In both pre- and post-deployment questionnaires, participants were assessed on their psychological distress (K10) (138), depressive symptoms (PHQ-9) (139), PTSD symptoms (PCL-C) (140), alcohol use (AUDIT)(141) and smoking status. For the purpose of this thesis, data pertaining to demographic, exposures, respiratory function and PTSD, as extracted from the MEAO questionnaire were utilised. A more detailed description of these measures are presented in the MEAO prospective study report (3, 133), and further detail about the measures used for the current study is outlined below.

Respiratory symptoms

This study gathered respiratory related data from three sections of the MEAO prospective questionnaire. The three sections assessing current respiratory symptoms include: "Recent Health Symptoms" (67-item questionnaire); "Your Health Now", a questionnaire comprising

self-reported doctor diagnoses; and “Your Respiratory Health” questionnaire (European Respiratory Health survey 2-screening questionnaire) (40, 142, 143).

Items assessing current respiratory symptoms were taken from the European Respiratory Health survey 2-screening questionnaire (143) and the 2011 Australian Gulf War Veterans Health Study follow-up (40). The 67-item adapted version of the self-report symptom questionnaire was originally based on the Hopkins Symptom Checklist developed and used by the King’s College Gulf War Illness Research Unit (40, 43, 142). This questionnaire asks about recent (in the past month) respiratory, cardiovascular, musculoskeletal, dermatological, gastrointestinal, genitourinary, neurological, neuropsychological or cognitive, and psychological symptoms. The respiratory symptoms/conditions drawn from this questionnaire include: persistent cough, shortness of breath, wheezing, unable to take deep breath, fast breathing, coughing, asthma, asthma attack, hay fever, tightness in chest, bronchitis, and sinus problems (see appendix 2.1 and 2.2 for more details). Items assessing current respiratory symptoms were also taken from the European Respiratory Health survey 2-screening questionnaire (37, 50).

For the purpose of this study, a measure of respiratory symptoms, including items from the Hopkin Symptom Checklist and the European Respiratory Health Survey, was created by grouping the symptoms as presented in Table 2.4.1. Respiratory symptoms were analysed both as a continuous measure (sum number of respiratory symptoms i.e. coughing, shortness of breath, hypersensitivity, tightness in chest, wheezing and sinus problems), with a total score of 0-6 as well as dichotomous (yes/no answer for presence or absence of any respiratory symptom listed in Table 2.4.1). Individual symptoms were not investigated due to the limited sample size, and because the purpose of this study was to investigate the association between deployment exposures and the overall shift in respiratory outcomes from pre- to post-deployment rather than individual symptom effects.

Table 2.4.1– Categories of self-reported respiratory symptoms

Categories	Specific self-reported symptoms
Coughing	Persistent cough Bronchitis (including both self-reported infective bronchitis and chemical induced bronchitis)
Shortness of breath	Unable to take deep breath Fast breathing
Hypersensitivity	Asthma attack (attacks of asthma in the past 12 months/ not being able to breathe due to sudden tightening of muscles around airways) Asthma (currently taking medication for asthma) Hay fever (nasal allergy)
Tightness in chest	
Wheezing	
Sinus problems	

Post-Traumatic Stress Disorder

This study used the PCL-C which is a 17-item self-report measure designed to assess the symptomatic criteria of PTSD. The 17 questions of the PCL-C are scored from 1 to 5 and are summed to give a total symptom severity score of between 17 and 85, with higher scores indicating increased severity (140).

In this study, PCL scores were used as both continuous and dichotomous variables. In accordance with the ADF post-operational screening, severity categories are able to be calculated from the PCL, with scores from 17 to 29 considered to be low, 30 to 39 medium, 40 to 49 high, and 50+ very high (144), however, due to the small number of participants (less than

0.5 %) meeting the diagnostic threshold for PTSD at pre-deployment and 1% at post deployment, scores on the PCL-C were instead categorised into 2 severity bands (Low and High) at pre- and post-deployment. Dichotomous categories were determined by plotting the distribution curve. This plot was not normally distributed, and therefore, a cut-off value of the 75th percentile was used to work out a score for high and low PCL (PCL scores over 25 = high; PCL scores equal or below 25 = low).

Psychological trauma exposures

The post-deployment self-report questionnaire contained 26 questions about specific traumatic deployment related experiences (3, 145). The 26 items were grouped into nine broad categories which were considered to be of a similar nature (Table 2.4.2). These groupings were based on previous research on combat exposures by Wilk et al. (2010) and were also used in the MEAO census study and prospective study reports (146).

The nine categories of traumatic deployment exposures include: coming under fire, discharging own weapon in direct combat at enemy, unable to respond to a threatening situation, vulnerable situations or fear of events, in danger of being killed/injured, seeing/handling dead bodies, casualties among those close to you, human degradation, and actions resulting in injury or death (Table 2.4.2).

Participants were asked if they had experienced each of the exposures while on deployment, and how many times they had experienced that exposure. A total score was calculated by summing the number of exposure types endorsed (minimum=0 maximum=9)(144, 147). This was then dichotomised using the median value to categorise exposure levels as low (≤ 2) or high (≥ 3).

Table 2.4.2 – Categories of Traumatic Deployment Exposures

Category	Items in the survey
Coming under fire	Came under small arms or anti-aircraft fire
	Came under guided or directed
	mortar/artillery fire
	Experienced indirect fire (e.g. rocket attack)
	Experienced an IED/EOD that detonated
	Experienced a suicide bombing
	Experienced a landmine strike
	Encountered small arms fire from an unknown enemy
Discharging own weapon	Discharged your own weapon in direct combat
Unable to respond to a threatening situation	Experienced a threatening situation where you were unable to respond due to the rules of engagement
Vulnerable situations or fear of events	Seriously feared you would encounter an IED
	Went on combat patrols or missions
	Participated in support convoys (e.g. re-supply, VIP escort)
	Concerned about yourself or others (including allies) having an unauthorised discharge of a weapon
	Cleared/searched buildings
	Cleared/searched caves
In danger of being killed/injured	In danger of being killed
	In danger of being injured
Seeing/handling dead bodies	Handled dead bodies
	Saw dead bodies
Casualties among those close to you	Heard of a close friend or co-worker who had been injured or killed
	Present when a close friend was injured or killed
	Heard of a loved one who was injured or killed
	Present when a loved one was injured or killed
Human degradation	Witness to human degradation and misery on a large scale
Actions resulting in injury or death	Believe your action or inaction resulted in someone being seriously injured
	Believe your action or inaction resulted in someone being killed

Environmental exposures

The environmental exposure scale was developed from MEAO Preliminary Study Focus Groups (3) and the Kings College London Phase 2 questionnaire (142). Environmental exposures included: local combustion sources (burn pits/fire), dust storm, inhaled fine dust fibres, cigarette smoking, diesel exhaust (aviation, marine or automotive fuel), aircraft fumes, toxic industrial chemicals, solvents (e.g. thinners, sealer, paints), live in an area recently sprayed with pesticides, and exposed to explosion (140).

Participants were asked if they had experienced each of the exposures while on deployment, and how many times they had experienced that exposure. For the purpose of this study, number of exposure times was not used, with the total score calculated by summing the number of exposure types endorsed (minimum=0 maximum=10) (3, 43, 148). The sum of exposure types was then dichotomised using the median value to categorise exposure levels as low (< 5) or high (≥ 5).

Objective respiratory measures

Participants underwent a series of physical testing components and neurocognitive assessments to evaluate the impact of deployment on health outcomes, including height, weight, waist and hip circumference recording, blood pressure testing, lung function spirometry testing, and cardiovascular fitness assessment. Photographs were also taken of each participant to assess dermatological skin changes. A 40ml blood sample was taken to measure chronic infections, inflammation markers and biochemistry. Of relevance to this thesis were the spirometry test and the measure of height and weight. The rest of the data were not utilised as they were not relevant to the purpose of this thesis. However, a summary of results and more information regarding the measures and protocols can be found in the MEAO health study: Prospective study report (3, 133).

Spirometry

Spirometry measures were performed and collected by a nurse during the pre- and post-deployment physical testing of ADF members. The test was performed according to the guidelines for conducting spirometry specified by Miller et. al, (2005) (135).

Height and age were recorded to calculate predicted respiratory function, and participants underwent spirometry using an Easy One™ spirometer. The ATS/ERS guidelines for conducting spirometry testing were used (136, 137). The use of the EasyOne spirometer, which corrects for gender, age and ethnicity using predicted normal, for all tests removed confounding factors such as age, gender, height, weight and ethnicity. Healthy Caucasian Australian population was set into the Spirometer as the reference population.

Three measures for evaluating respiratory health collected via spirometry were: forced expiratory volume at one second (FEV1) which is a measurement that calculates the amount of air a person can force out of their lungs in 1 second; forced vital capacity (FVC) is defined as the amount of air that can be forcibly exhaled from the lungs after taking the deepest breath possible; and the FEV1/FVC ratio which represents the proportion of a person's vital capacity that they are able to expire in the first second of forced expiration to the full, forced vital capacity.

Guidelines from the Global Initiative for Chronic Obstructive Lung Disease and from the International Consensus Statement sponsored by the ATS and the ERS suggest that airflow obstruction is present when the ratio of FEV1 to FVC is less than 70% of 'Predicted Normal Values' (136, 137). This criterion is set regardless of age and gender in an attempt to simplify the diagnosis. However, as the FEV1/FVC ratio is inversely proportional to age, the use of a fixed cut-off would be expected to 'over call' obstruction in older subjects and 'under call' obstruction in young individuals (137). The issue of overestimation or underestimation will not be of concern in this study as the majority of participants are young and fit military members,

meaning that by convention, an individual's lung function is taken to be low or 'abnormal' if it is below 70%, which could be suggestive of airflow limitation with obstructive pattern. A ratio above 70% is usually considered to be a 'normal' lung function measure (135, 137).

The FEV1/FVC ratio was used as a continious measure of respiratory function. In addition, dichotomous variables (sub-groups) were created by using the 'Global Initiative for Chronic Obstructive Lung Disease' (GOLD) standard cut off of 70% for FEV1/FVC. Participants were then divided into the following 2 sub-groups: 'Normal' = FEV1/FVC >70% pre- and post-deployment; 'Abnormal' = FEV1/FVC ≤70% pre- and post-deployment. Two additional sub-groups were created using the mean FEV1/FVC at pre- and post-deployment. 'Increased' = respiratory function measures (FEV1/FVC) increased at post deployment; and 'Decreased' = respiratory function measures declined at post deployment. The reason for creating these subgroups was that, in addition to the GOLD standard cut-off for Normal/Abnormal respiratory function, this study aimed to investigate the change in respiratory function and association with respiratory symptoms (136, 137).

2.5 Data Analysis

This section describes general statistical methods used in this thesis.

In order to answer the study questions, a number of analytical methods were employed. All analyses were performed using the statistical software package SPSS Statistics version 21 (IBM SPSS Statistics for Windows, Armonk, NY: IBM Corp) and Microsoft Excel 2016. For each outcome variable, the effect size was estimated with 95% confidence limits. Statistical significance was assessed at a level of $p \leq 0.05$. Descriptive analyses, linear, Poisson and binary logistic regressions were used depending on the nature of the specific question and variables included in the analysis.

Paired data were tested using a paired samples t-test or McNemar's test. For continuous outcomes, where appropriate, descriptive statistics including mean and confidence intervals are presented.

Descriptive statistics (including mean and confidence intervals) were provided for the demographic and service characteristics of the ADF members who completed both the spirometry test and questionnaire. The scores on these measures were compared between pre- and post-deployment. Standard error of mean and standard deviation were also reported where appropriate.

Mixed models for repeated measures were used for continuous outcomes This approach allows for the use of repeated measures on the same individual (i.e. pre- and post-deployment) in order to investigate changes in respiratory outcomes over time.

Univariate and multiple linear regression and Poisson regression methods were used to investigate the relationship between deployment exposures and FEV1/FVC and self-reported respiratory health outcomes post-deployment. In addition to show whether the FEV1/FVC means were increasing or decreasing across levels of respiratory symptoms and PCL scores, a univariate linear regression was performed.

A logistic regression model was used for dichotomous outcomes, (e.g. present, absent of respiratory symptoms) and the number and percentage of participants experiencing the outcome of interest is shown.

To plot the interaction effect of exposures and respiratory outcomes, linear regressions and 2-way interaction unstandardised formula were performed in Excel.

Independent sample t-tests were used to assess mean differences between sub-groups (e.g. Normal, Abnormal, Decreased lung function, and Increased lung function).

In order to determine if the differences in means were significant from pre- to post-deployment, paired sample t-tests were used.

As suggested by the literature, a number of demographic factors can impact on outcomes, therefore, all regression analyses were adjusted for age, cigarette smoking and pre-deployment measures where appropriate.

Listwise deletion was used in SPSS which did not include cases that have missing values on the variables under analysis. The small numbers in some of the sub-groups may mean that there was insufficient power to detect statistically significant differences.

Note: the MEAO prospective study (3), which analysed the same sample of ADF members, showed no significant association between smoking status or smoking behaviour and change in FEV1/FVC. Therefore this study did not repeat what was found previously. In this study, cigarette smoking was included as one of the environmental exposures and all regression analyses were adjusted for cigarette smoking where appropriate.

2.6 Summary

This thesis utilises data drawn from the MEAO prospective study and focuses on factors associated with respiratory health outcomes among a sample of ADF members deployed to the MEAO.This chapter has detailed all aspects of the research methodology used to investigate the research questions regarding the change in respiratory function among ADF personnel deployed

to the MEAO between 2010 and 2012 from pre-to post-deployment and the impacts of deployment exposures on respiratory outcomes. The detailed data analysis for each chapter is discussed in the methodology section of the corresponding chapter.

The results of the research study conducted in accordance with this methodology are reported in the next two chapters.

2.7 Ethics approval and consent to participate

This thesis is reporting studies involving human data, and therefore a low-risk Ethics approval was obtained from Joint Health Command Low-Risk Ethical Review Panel for Defence Health Research Ethics (approval number: DHRC/OUT/2016/R26893673).

Chapter 3 – Change in respiratory function from pre- to post-deployment to the MEAO among ADF personnel 2010-2012

3.1 Commentary

Recent studies suggest that respiratory function decline among military members may be the result of deployment, and indicative of future risk of respiratory conditions. Therefore, determining the level of respiratory distress (decline in objective respiratory function and increase in respiratory symptoms) following deployment of ADF members to the MEAO and predictors of these adverse respiratory outcomes is of theoretical importance and practical utility.

This chapter addresses the first aim of this study which is to investigate if similar to the reported international literature, there is an increase in subjective respiratory symptoms (self-reported respiratory symptom measured by questionnaire) of ADF members from pre- to post-deployment to the MEAO between 2010 and 2012 and whether these are accompanied by any changes in objective function (FEV1/FVC measured by spirometry), possibly at a sub-clinical level. The following chapter (Chapter 4) will investigate the second aim of this study which is to investigate the specific predictors of decline in respiratory function.

The use of MEAO prospective study data allowed a longitudinal analysis of both the objective and subjective measures of respiratory function. In addition to the prospective design of this study, the subset sample (n=202) selected for respiratory analyses was relevant as it represented a predominantly healthy, non-symptomatic cohort who were in combat roles and exposed to a variety of potentially traumatising factors, both physical and psychological. Identifying patterns of symptoms and predictors is important, because it may allow better monitoring and management of individuals who are at risk of developing further adverse respiratory outcomes following deployment.

This chapter summarises the existing literature on adverse respiratory health concerns within international and Australian military populations. Following that, short descriptive analyses of

the MEAO dataset will be presented to describe the features of the dataset relating to the respiratory health of ADF members. In addition, the analyses will address the study question of whether there is a change in respiratory function among ADF personnel deployed to the MEAO between 2010 and 2012 from pre-to post-deployment. While initial analyses of this dataset in the MEAO Prospective Study report (1) summarised changes in respiratory health, this chapter extends these findings, and is limited to the specific subsample utilised in this thesis.

3.2 Introduction

Australian troops have been actively involved in operations in the MEAO since 2001 as part of a global response to terrorism. In addition to combat injuries, the delayed health effects of operational service are of concern, particularly the psychological and physical effects of deployment exposures, such as environmental exposures, psychological trauma and other deployment exposures which may impact on the long-term respiratory health of military personnel (3, 4, 12, 13, 20-22, 37). The importance of examining health concerns is highlighted by consistent findings from post-deployment studies of personnel deployed in support of the GW1). These studies reported an increase in all somatic symptoms, including respiratory symptoms, by GW1 veterans compared with non-Gulf War comparison groups (5-7). The findings have been consistently replicated in a number of follow-up studies conducted many years after the end of the Gulf War (9, 40, 41, 43-45), which indicate that there may be characteristics of deployment that are associated with adverse health outcomes.

Current international studies regarding the more recent MEAO conflict (the Iraq and Afghanistan conflict since 2001), have also documented an increased incidence of respiratory symptoms (e.g. shortness of breath, wheezing, coughing, etc.) that may be indicative of early onset of a potentially serious disease, such as asthma, bronchitis, COPD, etc. (10, 13-15, 60).

Because of limitations in GW1 studies (i.e. difficulties in standardising exposures; cross-sectional, retrospective medical review; and the self-reported nature of many studies) (7, 9, 31, 40-45), it is difficult to discriminate associations with specific deployment-related exposures or to reach a robust conclusion regarding the relationship between exposure and adverse respiratory outcomes. The concerns and controversy regarding the respiratory symptoms following GW1 was one of the reasons why respiratory health and exposures following the Iraq and Afghanistan conflicts were monitored closely (3, 71, 88).

The current analyses utilised data from the MEAO prospective study to investigate if, in concurrence with international literature, that indicated both objective and subjective respiratory decline among military members after deployment to the Middle East, there is also a decline in objective and subjective respiratory functions of ADF members post-deployment to MEAO between 2010 and 2012.

To provide context for this study, the key adverse respiratory outcomes relevant to the international military personnel deployed to MEAO is first briefly described. Following this, MEAO prospective study data is used to determine the level of respiratory distress at pre- and post-deployment using both subjective and objective measures. Further background literature, including that pertaining to environmental and psychological and other exposures, are presented in Chapter 1 (literature review) of this thesis.

3.3 Method

The following is a summary of the sample and measures used in this chapter. Detailed methodology, including description of the sample, objective and subjective measures has been described in chapter 2 Methodology.

Sample

The sample was drawn from the MEAO prospective study which assessed the physical and mental health of ADF members deployed to the MEAO (3). The total eligible population was n=3074 which consisted of those units and ships that deployed to the MEAO during the study period (June 2010- June 2012). Of the eligible population n=1871 participants competed the pre-deployment survey. Of these 1324 participated post-deployment (133, 134).

This sample was further reduced at post-deployment to the final sample used for the current study which included 399 participants who completed the physical test at pre- and/or post-deployment. Of the 399, 197 were excluded due to not completing the spirometry test at both pre- and post-deployment, or they did not meet the criteria of 2005 American Thoracic Society (ATS) and European Respiratory Society (ERS) (3, 135-137). The remaining 202 participants formed the final sample used in these analyses.

Measures

Self-reported measure:

This study used both self-reported and objective measures to collect all pre and post deployment data for this study. Self-reported measures used in this chapter include respiratory symptoms gathered from three sections of the MEAO prospective questionnaire. The three sections assessing current respiratory symptoms include: "Recent Health Symptoms" (67-item questionnaire); "Your Health Now" (a questionnaire comprising self-reported doctor diagnoses); and "Your Respiratory Health" (European Respiratory Health survey 2-screening questionnaire) (40, 142, 143). See Table 2.4.1 Categories of self-reported respiratory symptoms in Chaper 2 Methodology.

Objective measure:

The objective measure included spirometry which was performed according to the guidelines for conducting spirometry specified by Miller et. al, (2005) (135). Height and age were recorded to calculate predicted respiratory function, and participants underwent spirometry using an Easy One™ spirometer. ATS/ERS guidelines for conducting spirometry testing were used (136, 137). Three measures for evaluating respiratory health collected via spirometry were: Forced Expiratory Volume at one second (FEV1), Forced Vital Capacity (FVC); and FEV1/FVC ratio. For more information about self-reported questionnaires and spirometry please refer to chapter 2 of this thesis, section 2.4 Measures.

Data Analysis

In order to describe the basic features of the data in this chapter descriptive analyses were used. Descriptive analyses provided simple summaries about the sample such as proportion and percentile and determined measures of central tendency, including mean and measures of dispersion including standard deviation and/or standard error of the mean. Descriptive statistics were provided for the demographic and service characteristics of the ADF members who completed both spirometry test and questionnaire. The scores on these measures were compared between pre- and post-deployment. Standard Error of Mean and Standard Deviation were also reported where appropriate. For the outcomes of the FEV1/FVC ratio and sum of respiratory symptoms, assumptions of a linear model were found to be upheld by inspection of histograms and scatter plots of predicted values and residuals (Tables 3.4.1 and 3.4.2).

Mixed models for repeated measures were used for continuous outcomes. For FEV1/FVC ratio and sum of self-reported respiratory symptoms and interaction between pre-post period within the characteristic sub-groups (i.e. age, sex, service, etc), a linear mixed-effects model of outcomes was used.This approach allows for the use of repeated measures on the same individual (i.e. pre- and post-deployment) in order to investigate changes in respiratory outcomes over time (Tables 3.4.1 and 3.4.2).

To demonstrate the Proportion N (%) of 'Normal' and 'Abnormal' respiratory function (FEV1/FVC) and the difference in mean FEV1/FVC from pre- to post-deployment, in addition to descriptive analysis, the McNemar test was used to calculate the significant difference from pre- to post-deplomen (Table 3.4.3).

A paired sample T-test was performed in order to distinguish between the proportion of participants who showed 'Normal' or 'Abnormal' respiratory function results at pre- and/or post-deployment and to identify new cases of 'Abnormal' lung function at post-deployment. Participants were broken down into four distinct groups and the results reported the frequency and percentage of ADF members who had 'Abnormal' respiratory function at: pre-deployment only, post-deployment only, at both pre- and post-deployment, or neither ('Normal' at both pre- and post-deployment) (Table 3.4.5).

To determine the proportion of ADF members and the number of respiratory symptoms (1-6 respiratory symptoms) reported at pre- and post-deployment, simple descriptive statistics (frequencies on SPSS) were used. Respiratory symptoms include coughing, shortness of breath, hypersensitivity, tightness in chest, wheezing and sinus problems. Differences from pre- to post-deployment were calculated using multivariable regression. See Table 3.3.3 for more details of respiratory symptom groups (Table 3.4.6).

In order to further determine whether the onset of respiratory symptoms preceded or followed deployment, this study examined the development of symptoms at post-deployment in those who were symptom-free versus symptomatic at pre-deployment. The paired analysis (McNemar test) addressed which lung function subgroups (i.e. Normal, Abnormal, Increased, Decreased) had a significant increase in incidence of newly reported respiratory symptoms at post-deployment as well as whether or not new respiratory symptoms at post-deployment reflects

clinical diagnosis guidelines using the GOLD standard cut off of 70% for FEV1/FVC (Table 3.4.7).

As suggested by the literature, a number of demographic factors can affect respiratory outcomes; therefore, all regression analyses were adjusted for age, cigarette smoking and pre-deployment measures where appropriate. Listwise deletion was used in SPSS, which did not include cases that have missing values on the variables under analysis.

Note: the MEAO prospective study (3) which analysed the same sample of ADF members, showed no significant association between smoking status or smoking behaviour and change in FEV1/FVC. Therefore, this study did not repeat what was found previously. In this study, cigarette smoking was included as one of the environmental exposures and all regression analyses were adjusted for cigarette smoking where appropriate.

3.4 Results

The following investigation aimed to establish evidence of change in respiratory health of ADF members between pre- and post-deployment to the MEAO.

The results in Tables 3.4.1 and 3.4.2 shows the change in the total sample mean FEV1/FVC and respiratory symptoms between pre- and post-deployment and whether demographic factors such as age, sex, service, prior deployment and smoking status affect adverse respiratory outcomes (decline in FEV1/FVC and increase in self-reported respiratory symptom) within a subset sample of ADF members deployed to MEAO (n=202).

No significant change was identified in the overall mean FEV1/FVC from pre- to post-deployment.

There were no significant differences in the change in FEV1/FVC ratio between pre- and post-deployment due to age, sex, service, prior deployment and current smoking status (Table 3.4.1).

Table 3.4.1 The effect of deployment on FEV1/FVC for responders who completed both pre- and post-deployment spirometry test (n total=202)

		FEV1/FVC			
Characteristics	**Sub-groups**	**Pre-deployment (n) [a]**	**Post-deployment (n)[a]**	**Comparison P value[b]**	**Interaction P value[b]**
Total sample		80.4 ± 0.5 (202)	80.0 ± 0.5 (202)	0.72	
Age	16-24	80.7 ± 0.8 (86)	81.6 ± 0.7 (86)	0.20	0.52
	25-34	80.5 ± 0.8 (86)	80.3 ± 0.7 (86)	0.75	
	35-44	79.0 ± 1.5 (26)	78.1 ± 1.3 (26)	0.45	
	45-54	81.8 ± 3.8 (4)	81.6 ± 3.2 (4)	0.94	
Sex	Female	82.5 ± 4.5 (3)	82.9 ± 3.8 (3)	0.93	0.97
	Male	80.0 ± 0.6 (175)	80.1 ± 0.5 (175)	0.67	
	Missing	(24)	(24)		
Service	Army	80.4 ± 0.6 (192)	80.5 ± 0.5 (192)	0.81	0.60
	Navy	81.2 ± 2.4 (10)	82.3 ± 2.1 (10)	0.56	
Prior deployment	No	80.8 ± 1.0 (54)	81.4 ± 0.9 (54)	0.44	0.82
	1-2	80.0 ± 0.8 (75)	79.9 ± 0.8 (75)	0.95	
	3-4	79.8 ± 1.4 (25)	80.0 ± 1.3 (25)	0.82	
	4+	80.0 ± 1.8 (16)	81.4 ± 1.6 (16)	0.54	
	Missing	(32)	(32)		
Current smoking	Yes	80.9 ± 0.8 (85)	81.0 ± 0.7 (78)	0.807	0.537
	No	80.1 ± 0.7 (103)	79.7 ± 0.6 (99)	0.496	

Key: [a] marginal means ± S.E.M. n = number of ADF participants. [b] linear mixed-effects models of outcome. The missing values in the sub-groups represent those with protected identities.

No significant change was identified in the overall self-reported sum of respiratory symptoms from pre- to post-deployment. There was also no effect of age, sex, service or deployment category on the change in respiratory symptoms between pre/post deployment, with the exception of age sub-group 35-44 years, who reported a significant increase in respiratory symptoms at post deployment (p=0.047) (by the use of interaction models; Table 3.4.2).

Table 3.4.2 The effect of deployment on self-reported respiratory symptoms for ADF members who completed self-reported questionnaires (n total=202)

		Sum of respiratory symptoms			
Characteristics	**Sub-groups**	**Pre-deployment (n)[a]**	**Post-deployment (n)[a]**	**Comparison P value**	**Interaction P value**
Total sample		0.6 ± 0.08 (202)	0.76 ± 0.09 (202)	0.130	
Age	16-24	0.58 ± 0.12 (86)	0.63 ± 0.13 (86)	0.738	0.26
	25-34	0.65 ± 0.12 (86)	0.83± 0.13 (86)	0.265	
	35-44	0.46 ± 0.21 (26)	1.04 ± 0.25 (26)	**0.047**	
	45-54	0.75 ± 0.55 (4)	0.00 ± 0.60 (4)	0.310	
Sex	Female	1.00 ± 0.63 (3)	2.00 ± 0.69 (3)	0.243	0.39
	Male	0.60 ± 0.08 (175)	0.78 ± 0.09 (175)	0.103	
	Missing	(24)	(24)		
Service	Army	0.59 ± 0.08 (192)	0.77 ± 0.09 (192)	0.089	0.31
	Navy	0.70 ± 0.34 (10)	0.40 ± 0.38 (10)	0.522	
Prior deployment	No	0.83 ± 0.15 (54)	0.96 ± 0.16 (54)	0.522	0.72
	1-2	0.52 ± 0.13 (75)	0.60 ± 0.14 (75)	0.643	
	3-4	0.68 ± 0.22 (25)	0.64 ± 0.25 (25)	0.899	
	4+	0.62 ± 0.27 (16)	0.99 ± 0.31 (16)	0.334	
	Missing	(32)	(32)		
Current smoking	Yes	0.08 ± 0.3 (85)	0.13 ± 0.3 (78)	0.183	0.509
	No	0.05 ± 0.2 (103)	0.08 ± 0.3 (99)	0.630	

Key: [a] marginal means ± S.E.M. n = number of ADF participants. [b] linear mixed-effects models

In order to examine the extent to which objective respiratory function changed in relation to clinical diagnosis guidelines, categories of respiratory function were assessed.The following table shows proportion N (%) of ADF members at pre- and post-deployment within objective respiratory function sub-groups 'Normal' and 'Abnormal' at pre- and post-deployment. This will provide a snapshot of the overal FEV1/ FVC status in the cohort of 202 participants in combat roles who have completed both the objective and subjective components of the study pre- and post-deployment.

Table 3.4.3 Proportion N (%) of 'Normal' and 'Abnormal' lung function (FEV1/FVC) at pre- and post-deployment

Normal		**Abnormal**	
Pre [a]	**Post [ab]**	**Pre [a]**	**Post [ab]**
194 (96%)	193 (95.5%)	8 (4%)	9 (4.5%)

Key: [a] Data are proportion N (%) of ADF participant at pre- and post-deployment within objective respiratory function sub-groups 'Normal' and 'Abnormal' at pre- and post-deployment. [b] Differences from pre- to post-deployment calculated using McNemar test. *P<0.05, ** P<0.001. (P=0.1 for both Normal and Abnormal sub-groups).

In addition to the GOLD standard cut-off for Normal/Abnormal respiratory function, this study investigated the shift in objective respiratory function. This provided further support in answering the question of this study regarding the change in respiratory outcomes from pre- to post-deployment. The mean FEV1/FVC at pre- and post-deployment was used to determine the proportion of ADF members who had an increase or decrease in objective respiratory function at post-deployment. The descriptive results in Table 3.4.4 showed that 55.7% of service members had a decrease in their respiratory function at post-deployment, while 44.3% showed improvement in respiratory function.

Table 3.4.4 Proportion N (%) of 'Increased' and 'Decreased' respiratory function measures at post-deployment

FEV1/FVC increased at post-deployment		FEV1/FVC decreased at post-deployment	
N	**%**	**N**	**%**
78	44.3	98	55.7

Key: [a] Data are proportion N (%) of ADF participants at post-deployment within objective respiratory function sub-groups 'Increased' and 'Decreased' respiratory function post-deployment.

The following results presented frequency and percentage of participants who had 'Abnormal' FEV1/FVC at pre-deployment only, post-deployment only, at both pre- and post-deployment, or neither.

In order to further distinguish between the proportion of participants who showed 'Normal' or 'Abnormal' respiratory function results at pre- and/or post-deployment and to identify new cases of 'Abnormal' respiratory function at post-deployment, participants were broken down into four distinct groups. The following results report the frequency and percentage of participants who had 'Abnormal' respiratory function at: pre-deployment only, post-deployment only, at both pre- and post-deployment, or neither.

Table 3.4.5 Frequency N (%) for 'Abnormal' FEV1/FVC at pre- and post-deployment

Abnormal FEV1/FVC	N[a]	%[a]
At pre [b]	4	2.0
At post [c]	5	2.5
At both [d]	4	2.0
Neither [e]	189	93.5
Total	202	100.0

Key: [a] Data are frequency N (%) of ADF participants with 'Abnormal' respiratory function: [b] at pre- deployment only, [C] post-deployment only (new cases of 'Abnormal' respiratory function), [d] at both pre-and post-deployment, [e] Normal at both pre-and post-deployment.

The purpose of the following descriptive table was to determine what proportion of ADF members reported one, two, three, four, five and six respiratory symptoms at pre- and post-deployment and whether the proportion of ADF members with more than one respiratory symptom increased from pre- to post-deployment.

Table 3.4.6 shows that the number of ADF members who reported 3 and 4 respiratory symptoms increased significantly from pre- to post-deployment $p<0.001$. The number of ADF members with 3 respiratory symptoms increased from pre- to post-deployment $P<0.001$, $B=2.9$, 95% CI (2.2, 3.5), marginal means S.E.M. ± 0.3. The number of ADF members with 4 respiratory symptoms increased from pre- to post-deployment $P<0.001$, $B=4.5$, 95% CI (3.1, 5.9), marginal means S.E.M. ± 0.7.

Table 3.4.6 Proportion N (%) of respiratory symptoms reported by ADF members pre- and post-deployment.

Number of respiratory symptoms	Pre-deployment		Post-deployment	
	N[a]	%[a]	N[a]	%[a]
0	131	64.9	121	61.1
1.00	45	22.3	38	19.2
2.00	14	6.9	18	9.1
3.00	6	3.0	11	5.6**[b]
4.00	2	1.0	8	4.0**[b]
5.00	2	1.0	1	0.5
6.00	2	1.0	1	0.5
Total	202	100.0	198	100.0

Key: [a] Data are frequency N (%) of ADF participants with 1-6 self-reported respiratory symptoms. Respiratory symptoms include: coughing, shortness of breath, hypersensitivity, tightness in chest, wheezing and sinus problems. See Table 3.3.3 for more details of grouping respiratory symptoms. [b] The differences from pre- to post-deployment were calculated using multivariable regression. Significant at *P<0.05, ** P<0.001.

The following analysis further established evidence of change in respiratory outcomes from pre- to post-deployment by investigating the prevalence of respiratory symptoms within the objective respiratory function sub-groups ('Normal', 'Abnormal', 'Increased' and 'Decreased' respiratory function). These analyses determined whether the onset of self-reported respiratory symptoms preceded or followed deployment, by examining the development of symptoms at post-deployment in those who were symptom-free versus those who were symptomatic on objective respiratory function tests at pre-deployment (table 3.4.7). As can be seen in Table 3.4.7, the proportion of respondents who were symptom-free at pre-deployment but developed

at least one respiratory symptom at post-deployment increased by 20.4% in the 'Normal' subgroup, by 14.2% in the 'Abnormal' sub-group, 16.6% in those who had 'Increased' objective respiratory function at post-deployment, and by 27.5% in those who had 'Decreased' objective respiratory function at post-deployment. However, the only significant increase was observed among those with 'Decreased' objective respiratory function at post-deployment (p=0.02) (Table 3.4.7).

In relation to the findings in Table 3.4.7, indicating that those with newly reported respiratory symptoms at post-deployment had significantly decreased objective respiratory function at post-deployment, this study further investigated if there was a linear relationship between the 4 objective respiratory function sub-groups and an increase in respiratory symptoms at post-deployment. The findings only showed a significant association between increased self-reported respiratory symptoms and decreased objective respiratory function at post-deployment (p=0.03, B= -0.86, 95% CI (-1.63,-0.09)), providing evidence of a link between changes in subjective and objective respiratory outcomes at post-deployment.

This study also observed that when considering self-reported respiratory symptoms among the various objective respiratory function subgroups, those with 'Abnormal' respiratory function more commonly reported at least one respiratory symptom compared to respondents with 'Normal' respiratory function (71.4% vs 37.7%) (p=0.07).

Table 3.4.7 Development of respiratory symptoms at post-deployment in those who were symptom-free at pre-deployment

FEV1/FVC at post-deployment	N [a]	Symptomatic at post N (%) [b]
Normal	191	39 (20.4)
Abnormal	7	1 (14.2)
Increased	78	13 (16.6)
Decreased	98	27 (27.5)*

Key: [a] Data are number of ADF participants pre- to post-deployment (paired data) within objective respiratory function subgroups. [b] proportion N (%) of those who were symptom-free at pre-deployment and symptomatic at post-deployment, significant value calculated by using the McNemar test, *P<0.05.

3.5 Discussion

This chapter aimed to establish evidence of change in respiratory health in a subset sample of relatively healthy MEAO deployed ADF members by summarising the self-reported and objective respiratory health prior to, and following deployment.

To date, there has been very limited prospective analysis of the respiratory health outcomes of ADF members following deployment. However, preliminary findings from the GW1 and MEAO prospective studies indicated an increase in self-reported respiratory symptoms (7, 40), as well as a decline in objective measures of respiratory function, following deployment to the MEAO (3, 88).

This study found no significant change in the overall mean FEV1/FVC and respiratory symptoms from pre- to post-deployment among a subset sample of ADF members deployed to

the Middle East from 2010 to 2012. Since the total sample analyses may not have adequately captured intragroup variabilities, in addition to examining the whole sample, this study utilised a common method used internationally (135-137) to further investigate the objective respiratory shifts within sub-groups. This method used the GOLD standard '70% cut-off' which distinguished between 'Normal' and 'Abnormal' FEV1/FVC sub-groups. Using this method, the ADF members were broken down into sub-groups according to their objective respiratory results.

Examination of the 'Normal' and 'Abnormal' sub-groups showed that while there are health restrictions in place for ADF enrolment, (i.e the ADF has historically precluded asthmatics from particular services or service roles) this study found that 4% met the global initiative for airway obstruction (FEV1/FVC ≤70%) at pre-deployment. This number increased to 4.5% at post-deployment (Table 3.4.5). While this is not a substantial increase, it highlights the fact that some ADF members with abnormal respiratory functions were deployed to MEAO and there is a possibility that this number increases at post deployment. This needs more careful investigations in a much larger cohort of ADF members to determine the possible risks of increase in respiratory function abnormality.

Deployment of ADF members with sub-optimal respiratory function may be the result of less stringent recruitment procedures compared to the UK and US military recruitment process. For example, since 2004, US military candidates diagnosed with asthma after the age of 13 have been excluded from military enlistment unless exempted via medical waiver (34). In the UK military, candidates may be disqualified from joining the military if suffering or having ever suffered from asthma (149).

Based on clinical evidence, medical standards for entry to the ADF are more relaxed, allowing some people with mild asthma to enter the ADF under guidelines (150). Since 2007, candidates

with mild asthma may be considered for entry to the ADF subject to certain criteria, including normal spirometry and negative bronchial provocation testing (150). While the medical process is quite detailed for the recruiting process, spirometry is not mandatory unless the candidate presents with a history of respiratory condition, such as asthma. Currently, if there is no history of asthma symptoms in the past 3 years, candidates are considered fit and continue through processing. Candidates with a history of any symptoms or treatment within 3 years have spirometry performed. In addition, only entry to some jobs at the ADF require spirometry, such as aircrew, divers, submariners and special forces (150).

Further analysis of the 'Abnormal' subgroups showed that from the total 9 (4.5%) 'Abnormal' cases identified at post-deployment, 4 (2%) had 'Abnormal' respiratory function results at both pre- and post-deployment while 5 (2.5%) were new cases of 'Abnormal' respiratory function at post-deployment (Table 3.4.5). Although these changes are small, the increase in new cases of abnormal respiratory function could be an indication of possible deployment risk factors influencing adverse respiratory outcome. Taking into consideration that the abnormalities in respiratory function are sub-threshold and not clinically evident, unless comprehensive medical tests such as spirometry are used. These sub-threshold respiratory abnormalities and symptoms, usually result in no reduction in ability to pass military fitness testing. However early identification of respiratory distress in military members may prove useful in determining strategies for prevention of adverse respiratory outcomes and aids earlier intervention, including recruitment guidelines, such as those followed by the US and UK.

Although the overall increase in the sum of self-reported respiratory symptoms among ADF members was not significant, further analysis of the number of respiratory symptoms within this cohort showed that the proportion of ADF members who reported 3 and 4 respiratory symptoms had significantly increased from pre- to-post deployment (Table 3.4.6). This is in line with increased reporting of respiratory symptoms in both GW1, and the Iraq and Afghanistan

conflict (5-9, 31, 151, 152). Previous military studies, i.e. GW1 studies, were generally limited by the lack of prospective design, meaning that it was not possible to determine the timing of symptoms. However, the design of the MEAO prospective study allowed determination of whether respiratory symptoms do in fact precede or follow deployment. This study was able to examine the development of respiratory symptoms at post-deployment in those who were symptom-free prior to deploying. The analysis addressed which respiratory function sub-groups had a significant increase in incidence of newly reported respiratory symptoms at post-deployment, as well as whether or not new respiratory symptoms at post-deployment reflects clinical diagnosis guidelines using the GOLD standard cut off of 70% for FEV1/FVC. The results showed a significant (27.5%) increase in incidence of newly reported respiratory symptoms within the sub-group with decreased respiratory function at post-deployment ($p=0.02$) (Table 3.4.7). This is further supported by the significant association observed between overall increase in respiratory symptoms and decrease in objective respiratory function $p=0.03$, $B=0.86$, 95% CI (-1.63, -0.09). In the other sub-groups 'Normal', 'Abnormal' and 'Increased', respiratory function also showed an increase in incidence of newly reported symptoms, however, these increases were not significant.

It is notable that even though the subgroup with 'Normal' objective respiratory function met the criteria for being clinically healthy, some participants in this sub-group were symptomatic. Therefore, if respiratory symptoms reflected the actual changes in respiratory function, it would be expected that people with 'Normal' or 'Increased' respiratory function would be asymptomatic. There are a number of possible explanations for this. It may be that self-reported respiratory symptoms are reflective of somatic distress rather than any actual impairment (9). However, it is possible that the presence of respiratory symptoms within the 'Normal' respiratory function group could reflect early respiratory decline, not yet manifesting as clinically abnormal diagnosis (106, 153).

In addition to establishing evidence of change in objective and subjective measures of respiratory function, this study has also found that respiratory function as measured by the FEV1/FVC ratio and sum of self-reported respiratory symptoms, between pre- and post-deployment, was not influenced by age, sex, service, prior deployment or current smoking status. This suggests that any possibility of increased risk of adverse respiratory outcomes may involve more specific exposures during deployment, such as environmental particulate matter or psychological stress of deployment, additional to the characteristics of ADF members or deployment alone (Table 3.4.1 and 3.4.2). Given the healthy state of military members at recruitment, existing research suggests that exposures such as environmental (particulate matter, metal particles, burn pit, air pollution), combat stress, and other exposures (physical activity, military living conditions and smoking) might be related to impairments in respiratory function among military members (10, 11, 20, 28, 57, 60, 152).

Even though this study found very little change in objective and subjective respiratory function, there was some indication of a shift in symptoms and possibly objective function. Considering the possible role of exposures from the literature, and the likely variations in levels of exposure within the sample, the next chapter will explore this further.

Although similar findings have been seen in other studies (3, 5-7, 9, 21, 31, 40, 45, 60), it is not possible to determine whether the higher rates of self-reported respiratory symptoms and reduced respiratory function were due to a higher occurrence of new respiratory conditions, somatisation, higher baseline prevalence, or reporting, selection, or confounding bias. Given the strengths of a prospective study with known base-line information, including descriptive, self-reported symptoms and objective data, this study demonstrates that there are some significant self-reported increases and minor and subtle decreases in objectively assessed respiratory function following deployment. Bearing in mind that deployment-related respiratory symptoms and conditions were expected to be subtle and that abnormalities in respiratory function may

have presented in a sub-syndromal form among otherwise healthy populations. In order to determine how meaningful these small changes and patterns are, careful evaluation of this cohort is required over time to determine the long-term impacts of deployment on syndromal respiratory conditions.It is important to understand that the minor increase in respiratory symptoms and decrease in objective indications may tip over at some point into clinically significant symptoms or probable disorders (131, 154). Identifying indicators of risk in still healthy individuals allows for mitigation strategies aimed at ultimately preventing poor health trajectories.

3.6 Conclusion

Overall, the findings of this chapter have established limited evidence of change in respiratory function via both subjective and objective respiratory measures from pre- to post-deployment among a subset sample of MEAO deployed ADF members between 2010 and 2012. Although the overall analyses of this cohort as a whole showed little decline in both the objective and subjective respiratory function post-deployment, further investigation of 'Normal' and 'Abnormal' respiratory function sub-groups showed significant changes in both the objective and subjective respiratory function which may have been masked if this study only considered the cohort as a whole.

There is a possibility that psychological trauma exposures or conditions such as PTSD influence respiratory function via changes in autonomic and immune systems (as discussed in the introduction to this thesis). In addition, the possibility of somatisation and self-reported symptoms reflecting mental distress rather than any actual respiratory impairment also remains. Therefore, the link between deployment exposures, psychological conditions, immune changes and adverse respiratory outcomes, deserves further investigation.

Early identification of potential underlying differences in affected and non-affected ADF members may prove useful in determining strategies for prevention of adverse respiratory outcomes and aid earlier intervention, including recruitment guidelines, such as those followed by the US and UK. These results together with investigation of possible risk factors may contribute significantly to long term respiratory health outcomes of the deployed ADF population. Therefore, next chapter (Chapter 4) of this thesis aimed to examine predictors of adverse respiratory health in the context of combat environmental and psychological trauma exposures among the same cohort of Middle East deployed ADF members.

Chapter 4 – Impacts of deployment exposures on adverse respiratory outcomes of ADF members deployed to the MEAO between 2010 and 2012

4.1 Commentary

Current international studies suggest that there is strong evidence on the cause of adverse respiratory outcomes among otherwise healthy military members deployed to the MEAO (3)Given the healthy state of service members at recruitment, existing research suggests that one contributing factor to the observed decreases in objective lung function measures and increases in self-reported symptoms may be the impact of deployment exposures.

Following on from the findings of Chapter 3, which suggested that deployment may increase the risk of adverse respiratory outcomes among a subset of ADF members deployed to the MEAO, the aim of this chapter was to examine the predictors of adverse respiratory outcomes among ADF members deployed to the MEAO between 2010 and 2012, in the context of environmental, psychological trauma and other exposures on deployment.

The findings are of importance to the ADF, providing evidence that deployment exposures and subtle adverse respiratory outcomes should be a focus of clinical intervention and assessment of individuals who are at risk, post deployment, in order to prevent future respiratory burden.

4.2 Introduction

Military research and clinical practice have aimed to systematically document physical and mental problems experienced by deployed service members. Given the evidence from the GW1 studies regarding the higher prevalence of respiratory symptoms (5-9) and the nature of military service which involves the prolonged and repeated exposures of individuals to a wide and potentially extensive level of exposures, recently, much attention has been paid to the health outcomes of the MEAO-deployed ADF members (3).

Together, findings (discussed in detail in chapter 1) suggest that there may be some characteristics of deployment that are associated with adverse physical health outcomes (5, 6, 8, 9).

While the underlying reasons for the high prevalence of adverse respiratory symptoms and conditions (e.g. shortness of breath, wheezing, coughing, asthma, chronic and acute bronchitis, and emphysema) among military personnel during and following deployment to the Middle East are not well understood (10-12), it has been suggested that the main cause of these respiratory conditions may be the environmental exposures (e.g. silicosis caused by breathing in tiny particles of silica, a mineral that is a component of sand, rock, and mineral ores such as quartz) . Nevertheless, so far, no specific association has been established between specific MEAO exposures and adverse respiratory outcomes, or the onset of serious disease in bothGW1 and the Iraq and Afghanistan studies (3, 8, 9, 16). The main limitations in these studies include: standardising exposure measures, cross-sectional study designs, retrospective medical review, and the self-reported nature of measures in many studies, which make it difficult to reach a robust conclusion regarding any potential relationship between deployment exposures and adverse respiratory outcomes (3).

Despite the equivocal findings overall, there is evidence that many characteristics of deployment may be associated with adverse respiratory outcomes, including exposure to various airborne contaminants, burn pits, dust, particulate matter, industrial fires and traumatic exposure (10, 13). In addition, evidence suggests tobacco smoking, stress, physical activities and other individual susceptibility factors such as age, sex, body mass index (BMI), blood pressure, physical fitness, pre-existing conditions and personal characteristics may also increase the risk of respiratory symptoms and may enhance susceptibility to environmental exposures (11, 17-19). Some of these risk factors are described in detail in chapter 1 of this thesis,

including: physical activity under stressful conditions (11, 19), smoking (3, 10, 11, 13, 17, 18) and individual susceptibility factors (10, 12, 151).

The limited available evidence from the GW1 studies indicated that exposure to environmental factors such as smoke from oil wells (SMOIL), dust or sand has not adversely affected the long-term respiratory health of GW1 veterans. The fact that the GW1 results consistently find self-reported respiratory impacts but little or no evidence of objective declines and no evidence of associations with environmental exposures, suggests that factors other than deployment alone or environmental exposures are likely to contribute to the observed respiratory symptoms. There is also a possibility that the exposures were not intense enough to affect objective respiratory function or the self-reported impacts likely reflect somatisation as a result of psychological stress or conditions such as PTSD (26-28, 46, 47). However, as the measures were cross-sectional, and there were no clinically meaningful associations, this doesn't answer the question of whether there were changes in objective respiratory function, below clinical cut-offs (5-9, 31, 32, 34-37, 40-42, 60, 155-157). This is a gap in knowledge that this chapter is able to address.

Despite inconsistent GW1 findings studies of the Iraq and Afghanistan conflict since 2001 have provided more comprehensive evidence that exposure to airborne particulate matter in the deployed environment may explain some of the increased respiratory symptoms and conditions documented in military populations. Several Iraq and Afghanistan conflict studies established evidence of environmental exposures and negative effects on respiratory outcomes (11, 12, 20-24). The key consistent messages that comes from the Iraq and Afghanistan military respiratory health studies include decline in respiratory function associated with environmental factors (11, 18, 20-24, 33).

In addition to ambient airborne hazards, it has been suggested that factors unique to military service that may increase the vulnerability of military personnel to respiratory health risk

include high levels of psychological stress which may be considered traumatic. These include: being exposed to threatening situations, stressful events, vulnerable situations, witnessing killing, death and violence, suicide, torture, and other atrocities(5, 53).

Despite evidence of high levels of stress in this population and general links between psychological trauma and adverse respiratory outcomes, exposure to psychological trauma has been less investigated than environmental exposures, but remains an important factor that may also be related to decline in respiratory function (26-28, 46, 47, 53, 76, 107, 108, 111, 113). In addition, it has been suggested that chronic stress may alter respiratory response to air pollution and may help elucidate pathways for differential susceptibility (76).

The effects of a stressful combat environment on a soldier's health are complex and may result in a broad spectrum of changes in the immune system, which could in turn increase vulnerability to various diseases and respiratory conditions (11).

The fact that a number of studies have found positive associations between psychosocial stress and respiratory symptoms (28, 34-36, 47, 53) suggests that, in the context of military service and deployment specifically, in addition to the established risk of environmental exposures, the psychological stress of deployment should be considered as an important contributing factor.

In addition to psychological traumatic stress, studies have also suggested a connection between psychological conditions such as PTSD and respiratory symptoms (14, 32, 60, 62).

Biological mechanisms of PTSD involves changes in the hypothalamic– pituitary–adrenal axis and the sympathetic–adrenal–medullary system (63). It has been suggested that these alterations lead to a pro-inflammatory state (65-67, 147). As inflammatory processes are involved in

airflow limitation, it is plausible that inflammation may be the link between trauma exposure and PTSD on the one hand, and airflow limitation on the other (60, 68).

With the current indication of links between trauma exposures, PTSD and adverse respiratory outcomes, it is important to investigate these relationships given the prevalence of such disorders are high within the military populations(14, 60, 62, 156).

The possibility of associations between sub-threshold PTSD with sub-clinical symptoms is also an important factor to consider regarding respiratory function, as the rate of full PTSD is expected to be relatively low among deploying populations.

With reference to the available evidence, it appears that deployment environmental and psychological exposures may both be associated with adverse respiratory health outcomes. More comprehensive prospective studies are needed to further clarify the association between environmental exposures, psychological trauma, PTSD and adverse respiratory outcomes in military populations (14, 32, 60, 62).

In addition to deployment specific risks, evidence suggests other factors such as physical activity (72) increased tobacco use (18, 73), and other individual susceptibility factors (84) may increase the risk of respiratory symptoms and enhance susceptibility to environmental and trauma exposures in this population. Therefore, when examining environmental and psychological factors, it is important to also consider other factors that may influence respiratory outcomes (19, 28, 76, 77).

The current study

The current study used data from the MEAO prospective study and focused on deployment related factors that may be associated with respiratory health outcomes among a sample of ADF members deployed to the MEAO.

While many previous studies have been prompted by a collection of ill-defined self-reported symptoms that were attributed to service in the area of operations but without (as yet) a clear causal or diagnostic link having been established (known as First Gulf War Syndrome), (5, 6, 132), the MEAO prospective study focused on a range of potential health outcomes of direct relevance to the nature of the deployment, including those identified by the Institute of Medicine (e.g. neurocognitive and neurobehavioral effects, hypertension and chronic respiratory effects etc.) (93). Rather than relying solely on subjective assessments, the MEAO prospective study collected objective health measures prior to and again after deployment in order to identify early markers of the psychological and physical impacts of combat stress and the other exposures of interest (3). This provided a unique opportunity to understand the short-term impacts of deployment-related exposures on the respiratory health of ADF members

The association between deployment-related environmental, combat and other exposures (smoking, physical activity, military living conditions), and psychological trauma with adverse respiratory outcomes, may be via direct actions (such as deposition of particulate matter) or by disturbance of the immune system (by stress/ trauma). While psychological trauma is highly prevalent in relation to deployment, its effect on respiratory health outcomes and potential mechanisms underlying associations, as well as potential predictors of good or adverse respiratory health over time, are not well understood (61, 129, 130). It is important to understand that the cumulative impact of deployment exposures and subsequent minor symptoms and objective indications, may tip over at some point into clinically significant symptoms or probable disorders (131). Identifying indicators of risk in still healthy individuals

allows for strategies aimed at ultimately preventing poor health trajectories. Therefore, on the basis of the existing research and literature, summarised earlier in this thesis, first it is hypothesised that environmental and psychological trauma exposures will independently and combined have adverse effects on self-reported respiratory symptoms and objective respiratory measures (FEV1/FVC) among ADF members deployed to the MEAO between 2010 and 2012. Second, psychological trauma exposure may act as a moderator on the relationship between environmental exposure and objective lung function or respiratory symptoms. Furthermore, as there is evidence of the link between trauma exposure and psychological symptoms, including PTSD (63, 65, 147) and there is emerging evidence of a link between PTSD and self-reported respiratory symptoms (29, 60, 61), in addition to examining the effect of environmental and psychological trauma exposures, this study also hypothesised that objective respiratory function is expected to be lower in the sub-groups with high PCL scores and respiratory symptoms compared to sub-groups with low PCL scores and no respiratory symptoms. (The PCL is a standardized self-report rating scale for PTSD comprising 17 items that correspond to the key symptoms of PTSD; see Chapter 2 section 2.4 self-reported measures for more details).

In order to ascertain whether psychological trauma exposure (i.e. stress on deployment) acts to sensitise an individual to greater reactivity to environmental exposures, this study examined whether psychological trauma exposure moderated the association between environmental exposures and lung function and respiratory symptoms. The examination of both objective and self-reported measures enabled this study to address the question of whether these impacts were physical or somatic in nature.

Further, this study examined whether any association between PTSD symptoms and respiratory symptoms is reflected by objective deficits in respiratory function. In order to establish any association, this study first established evidence of association between psychological trauma exposures and PCL score within this cohort. Following that, the difference in mean FEV1/FVC

in the sub-groups with low and high PCL scores and sub-groups with and without respiratory symptoms were tested.

In addition to examining the effects of environmental exposures and psychological trauma exposures as possible predictors of change in FEV1/FVC ratio and self-reported respiratory symptoms at post-deployment, this study further investigated if there is a difference between the sub-groups in terms of level of environmental and psychological trauma exposures. This was achieved by inspecting whether those ADF members with 'Abnormal', 'Decreased' FEV1/FVC, 'High PCL scores' and 'respiratory symptom' have higher mean environmental and psychological trauma exposure compared to the 'Normal', 'Increased', 'Low PCL' and 'No respiratory symptom' sub-groups.

4.3 Method

The following are summary of measures used in this chapter. Detailed methodology, including description of sample (Section 2.3), objective and subjective measures (Section 2.4) has been described in chapter 2 Methodology.

Measures

Self-reported measures:

A self-reported questionnaire was used to collect pre and post deployment data on Post-Traumatic Stress Disorder, respiratory symptoms, environmental and psychological trauma exposures of ADF members.

- Post-Traumatic Stress Disorder

This study used the PCL-C which is a 17-item self-report measure designed to assess the symptomatic criteria of PTSD. The 17 questions of the PCL-C are scored from 1 to 5 and are

summed to give a total symptom severity score of between 17 and 85, with higher scores indicating increased severity (140).

In this chapter, PCL scores were used as both continuous and dichotomous variables. PCL scores over 25 were considered high and PCL scores equal or below 25 were considered low.

- Respiratory symptoms

This study gathered respiratory related data from three sections of the self-report survey: "Recent Health Symptoms", self-reported doctor diagnoses, and the European Respiratory Health survey 2-screening questionnaire (40, 142, 143).

The respiratory symptoms/conditions drawn from this questionnaire include: persistent cough; shortness of breath; wheezing; unable to take deep breath; fast breathing; coughing; asthma; asthma attack; hay fever; tightness in chest; bronchitis; and sinus problems.

Respiratory symptoms were analysed both as a continuous measure (sum number of respiratory symptoms i.e. coughing, shortness of, breath, hypersensitivity, tightness in chest, wheezing and sinus problems), with a total score of 0-6 as well as dichotomous (yes/no answer for presence or absence of any respiratory symptom listed in Table 3.3.3). Individual symptoms were not investigated.

- Sum of environmental exposures

The environmental exposure scale was developed from MEAO Preliminary Study Focus Groups and the Kings College London Phase 2 questionnaire. Environmental exposures included: local combustion sources (burn pits/fire), dust storm, inhaled fine dust fibres, cigarette smoking, diesel exhaust (aviation, marine or automotive fuel), aircraft fumes, toxic industrial

chemicals, solvents (e.g. thinners, sealer, paints), living in an area recently sprayed with pesticides, and exposure to explosion (40). The total score calculated by summing the number of exposure types endorsed (minimum=0 maximum=10) (43, 148). The sum of exposure types was then dichotomised using the median value to categorise exposure levels as low (< 5) or high (≥ 5).

- Psychological trauma exposure

The post-deployment self-report questionnaire contained 26 questions about specific traumatic deployment related experiences (3, 145). The 26 items were grouped into nine broad categories which were considered to be of a similar nature (Table 4.3.1). These groupings were based on previous research on combat exposures by Wilk et al. (2010) and were also used in the MEAO census study and prospective study reports (146).

The nine categories of traumatic deployment exposures include: coming under fire, discharging own weapon in direct combat at enemy, unable to respond to a threatening situation, vulnerable situations or fear of events, in danger of being killed/injured, seeing/handling dead bodies, casualties among those close to you, human degradation, and actions resulting in injury or death. A total score was calculated by summing the number of exposure types endorsed (minimum=0 maximum=9) (144, 147). This was then dichotomised using the median value to categorise exposure levels as low (≤ 2) or high (≥ 3). (See Chapter 2, Table 2.4.2 for more details regarding categories of traumatic deployment exposures).

- Spirometry

Spirometry measures were collected during the pre- and post-deployment physical testing of ADF members. (135). Three measures for evaluating respiratory health collected via spirometry were: Forced Expiratory Volume at one second (FEV1), Forced Vital Capacity (FVC), and FEV1/FVC ratio.

The FEV1/FVC was used as a continuous measure of lung function. In addition, since the total sample analyses may not have adequately captured intragroup variabilities, in addition to examining the whole sample, this study utilised a common method used internationally to further investigate the objective respiratory shifts within sub-groups(135-137). Therefore, dichotomous variables (sub-groups) were created by using the 'Global Initiative for Chronic Obstructive Lung Disease' (GOLD) standard cut off of 70% for FEV1/FVC. Participants were then divided into the following 4 sub-groups:

'Normal'= FEV1/FVC >70% pre- and post-deployment; 'Abnormal'= FEV1/FVC <70% pre- and post-deployment; 'Increased'= lung function measures (mean of FEV1/FVC) increased at post-deployment; and 'Decreased' = lung function measures declined at post-deployment (135, 137).

Data Analysis

Univariate and multiple linear regression and Poisson regression methods were used to investigate the relationship between deployment exposures and FEV1/FVC and self-reported respiratory health outcomes post-deployment. Multivariable linear regressions were used for the continuous outcome variable 'FEV1/FVC', and Multivariable Poisson regression was used for the outcome variable 'respiratory symptoms' (Poisson regression is similar to regular multiple regression except that the dependent variable is an observed count that follows the Poisson distribution). Frequency, Mean ± SEM, significant value at $p<0.05$, 95% Confidence Interval and the estimate for linear regression or the Incidence Rate Ratio (IRR) for Poisson regression were reported. Regressions were adjusted for age, cigarette smoking, FEV1/FVC at pre-deployment or sum of respiratory symptoms at pre-deployment depending on the outcome being examined (Table 4.4.1).

To investigate the possible predictors of change in respiratory health between pre- and post-deployment, a series of multivariate regressions were performed. Specifically, the effects of environmental exposures, psychological trauma exposures, and their interaction, on FEV1/FVC ratio and self-reported respiratory symptoms at post-deployment were tested. Multivariate analyses were used to find patterns and relationships between several variables simultaneously, allowing for prediction of the effect a change in one variable will have on other variables.

To investigate which exposures have more influence on FEV1/FVC and self-reported respiratory symptoms, both environmental and psychological trauma exposures were put in the same regression model. Significant value at $p<0.05$, 95% Confidence Interval and the estimate for linear regression were reported.

To plot the interaction effect of environmental and psychological trauma exposures for the outcomes FEV1/FVC and self-reported respiratory symptoms, linear regressions and 2-way interaction unstandardised formula were performed in Excel (Figure 4.4.1 and figure 4.4.2).

In addition to analysis of interaction between the two environmental and psychological trauma exposure variables, a correlation test was performed (not shown in table) to evaluate the association between the two variables. In addition, significant value at $p<0.05$ and correlation coefficient 'r' ('r' indicates the strength of the relationship) were reported (these analyses and results were reported in text and not in tables).

Further, this study examined the role of PTSD symptoms (measured by PCL score) in relation to respiratory health. To examine the association between PCL score and psychological trauma exposures and respiratory symptoms, binary logistic regression models were used.

To examine the association between PCL score and FEV1/FVC, a univariate linear regression was performed. This test showed whether the FEV1/FVC estimated marginal means were increasing or decreasing across levels of respiratory symptoms and PCL scores (Table 4.4.2, Figure 4.4.3). The aim of this univariate analysis was not to examine causation or take into account the effect of potential confounders, but to simply find patterns in the data.

In addition to establishing evidence of the effects of environmental exposures and psychological trauma exposures as possible predictors of change on FEV1/FVC ratio and self-reported respiratory symptoms at post-deployment, this study further investigated if there was a difference between the sub-groups in terms of levels of environmental and psychological trauma exposures. This was achieved by inspecting whether those ADF members with 'Abnormal', 'Decreased FEV1/FVC', 'High PCL scores' and 'Respiratory symptoms' have higher mean environmental and psychological trauma exposure compared to 'Normal', 'Increased', 'Low PCL' and 'No respiratory symptom' sub-groups. An independent-samples t-test was performed to compare the difference in mean environmental and psychological trauma exposures between sub-groups. Significant value at $p<0.05$ was also reported (Table 4.4.3).

The MEAO prospective study which analysed the same sample of ADF members, showed no significant association between smoking status or smoking behaviour and change in FEV1/FVC (3). Therefore, this study did not repeat what was found previously. In this study, cigarette smoking was included as one of the environmental exposures and all regression analyses were adjusted for cigarette smoking where appropriate.

4.4 Results

Following on the analyses from Chapter 3 which suggested that some sub-groups appear to have evidence of change in respiratory function, this study further examined factors that may influence the extent to which respiratory change is observed.

To investigate the possible predictors of change in respiratory health between pre- and post-deployment, a series of multivariate regressions were performed. Specifically, the effects of environmental exposures, psychological trauma exposures, and their interaction, on FEV1/FVC ratio and self-reported respiratory symptoms at post-deployment were tested.

Results in Table 4.4.1 showed that environmental exposures (estimate=-0.02, 95% CI (-0.04, -0.00), p=0.01) and psychological exposures (estimate=-0.21, 95% CI (-0.41,-0.01), p= 0.04) were both negatively associated with lung function (FEV1/FVC) at post-deployment, and the interaction between these was significant (interaction p value =0.010). Specifically, as can be seen in Figure 4.4.1, when psychological trauma was low, there was no difference in lung function of those with 'high' compared to 'low' environmental exposures. However, when psychological trauma was high, lung function was reduced with increasing environmental exposures.

The same pattern of findings was observed for self-reported respiratory symptoms (Table 4.4.1, Figure 4.4.2): environmental exposures (IRR= 1.01, 95% CI (1.00, 1.02) p<0.001) were positively associated with sum of respiratory symptoms at post-deployment. While psychological exposure (IRR=1.00, 95% CI (-0.93, 1.081) p= 0.96) didn't have a significant independent effect on respiratory symptoms, the interaction between environmental and psychological exposures was significant (interaction P value<0.001). As can be seen in Figure 2, again, under conditions of low psychological trauma, there was no difference in the respiratory symptoms of those with 'low' compared to 'high' environmental exposures. When

psychological trauma was high, higher environmental exposures were associated with increased respiratory symptoms.

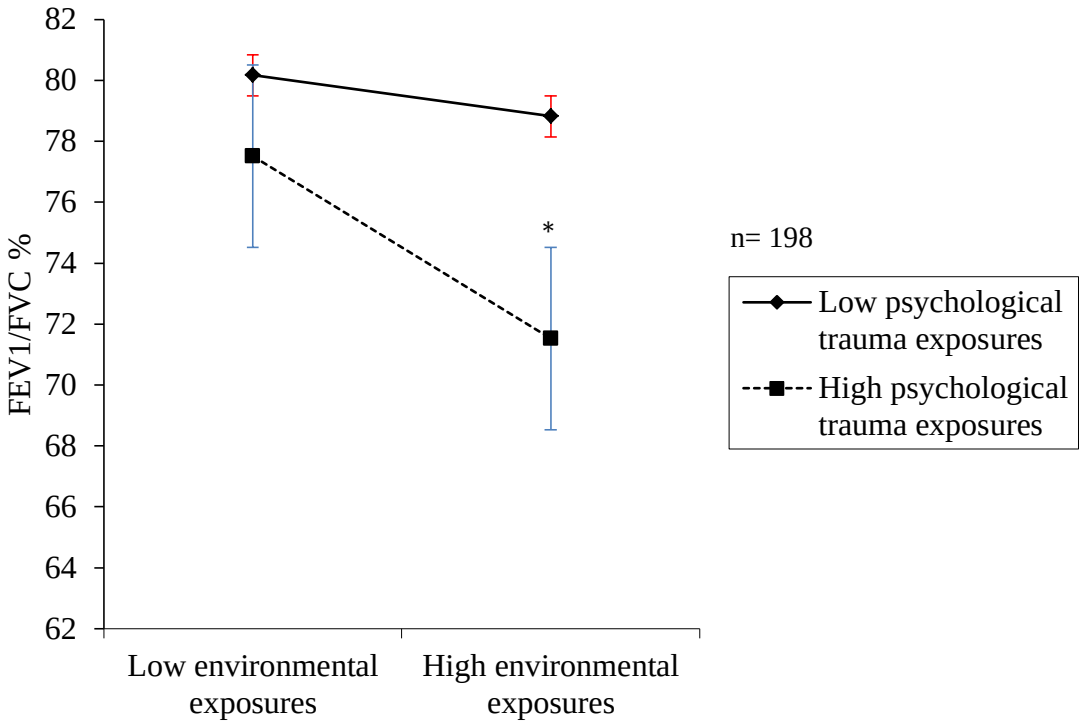
A correlation test was performed to further establish evidence of correlation between environmental and psychological trauma exposures. The result showed that the two variables were significantly correlated, however, their correlation was weak (P= 0.00, r=0.19) (not shown in table).

Table 4.4.1 Individual and combined effects of environmental and psychological trauma exposures on FEV1/FVC measures and sum of respiratory symptoms of MEAO deployed ADF members (n total=202)

Post-deployment	**Estimate [a] /IRR [b] (95% CI) [c]**		**Mean ± SEM***
FEV1/FVC	Environmental exposure	-0.02 (-0.04, -0.00) [a]	46.3 ± 0.01 (198) *
	Psychological trauma exposure	-0.21 (-0.41, -0.01) [a]	2.5 ± 0.10 (193) *
	Environmental x psychological trauma exposures	-0.02 (-0.04, -0.00) [a]	48.7 ± 0.01 (198) *
Sum of respiratory symptom	Environmental exposure	1.01 (1.00, 1.01) [b]	47.0 ± 0.00 (195) *
	Psychological trauma exposure	1.00 (-0.93, 1.08) [b]	2.5 ± 0.04 (190)
	Environmental x psychological trauma exposures	1.01 (1.00, 1.02) [b]	49.4 ± 0.03 (195) *

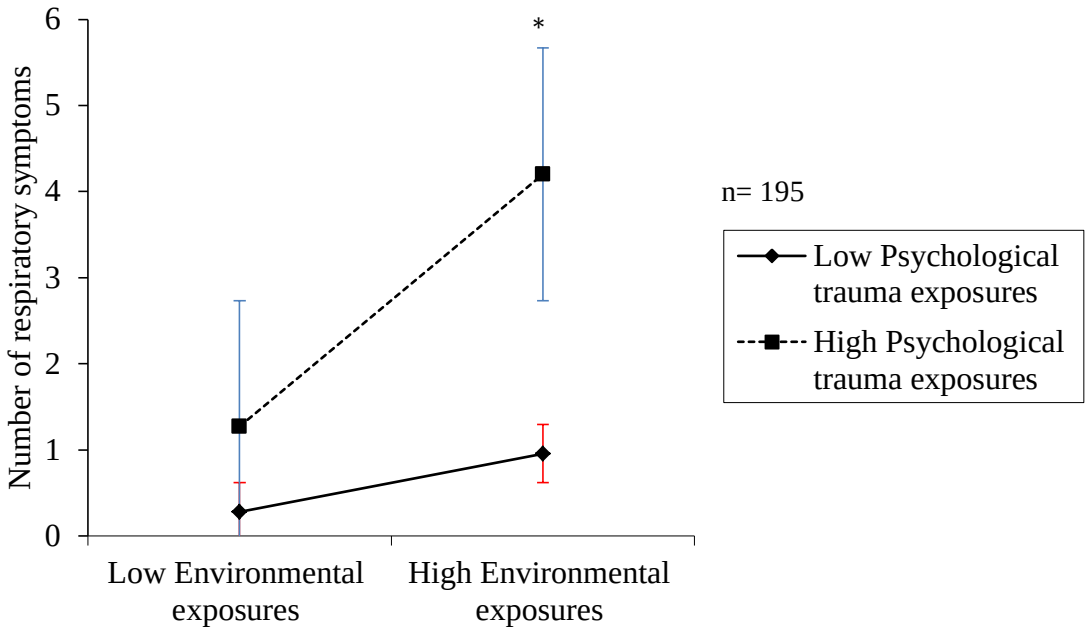
[a] Multivariable linear regression, [b] Multivariable Poisson regression, Mean ± S.EM (N), *Significant at $p<0.05$. [C] The estimate for linear regression or the Incidence Rate Ratio (IRR) for Poisson regression. 95% CI is 95% Confidence Interval. Regressions were adjusted for age, cigarette smoking, FEV1/FVC at pre-deployment or sum of respiratory symptoms at pre-deployment depending on the outcome being examined.

Figure 4.4.1 Effect of psychological trauma exposure on the relationship between environmental exposure and FEV1/FVC



Linear regression, 2-way interaction unstandardised formula were performed in Excel, significant at *P<0.05

Figure 4.4.2 Effect of psychological trauma exposure on the relationship between environmental exposure and respiratory symptoms



Linear regression, 2-way interaction unstandardised formula were performed in Excel, significant at *P<0.05

In addition, the regression analyses also indicated that when both environmental and psychological trauma exposures were put in the same regression model, environmental exposures assuming the strongest predictor (estimate -0.02, 95% CI (-0.03, -0.00), p=0.03) eliminated the effect of psychological trauma exposure (estimate -0.20, 95% CI (-0.40, 0.03), p=0.10) on FEV1/FVC so that psychological trauma no longer appears to be significant. This indicates that environmental exposures have more influence on FEV1/FVC compared to psychological trauma exposures.

The following analysis examined the associations between posttraumatic stress symptoms, and respiratory health outcomes. This analysis first examined if, in line with international findings, there is an association between psychological trauma exposures and PCL scores within the cohort of ADF members deployed to the Middle East. Subsequently, to establish a link between

psychological symptoms and adverse respiratory outcomes, this study examined if there is an association between high PCL scores with FEV1/FVC, and self-reported respiratory symptoms. Using binary logistic regression models, results showed that psychological trauma exposures were associated with higher PCL scores (Odds Ratio=3.2, 95% CI: (0.44, 1.87), $p<0.001$). In addition, higher PCL scores were also found to be associated with respiratory symptoms in an adjusted model (Odds Ratio=1.30, 95% CI (0.07, 0.45), $p<0.001$). However, the association between high PCL scores and objective lung function (FEV1/FVC) was not significant in an adjusted analysis (Odds Ratio=0.98, 95% CI (0.04, 0.00), $p=0.14$). Therefore, this study further investigated if having or not having respiratory symptoms in sub-groups with high PCL would make a difference in terms of mean FEV1/FVC. The following series of analyses were performed to observe the pattern of relations between objective lung function differences in sub-groups with or without respiratory symptoms and 'high' or 'low' PCL scores.

A univariate linear regression was performed. This test established whether the FEV1/FVC estimated marginal means were increasing or decreasing across levels of respiratory symptoms and PCL scores.

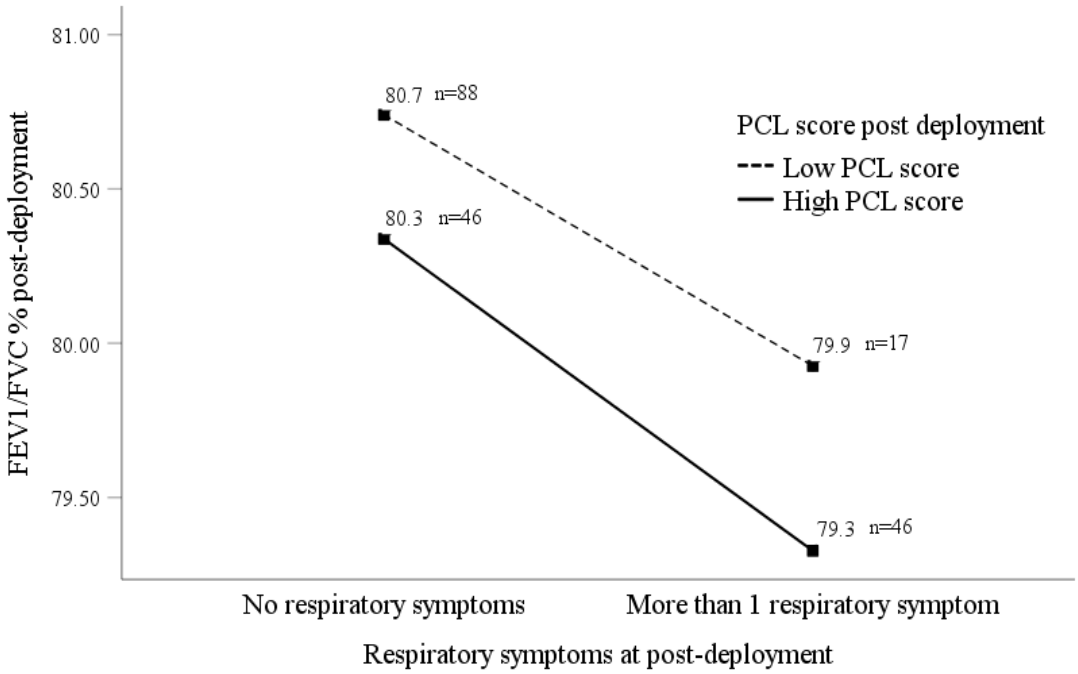
The results showed that although the absolute differences in mean FEV1/FVC between high and low PCL sub-groups were small and not significant, the slope were almost identical for the two sub-groups, suggesting that overall there is no difference between the high and low PCL subgroups in terms of the association between respiratory symptoms and lung function. However, looking at the overall pattern for both PCL sub-groups, lung function was lower in those with higher respiratory symptoms. This suggests that having respiratory symptoms may be an important identifying factor for lower FEV1/FVC regardless of having high or low PCL scores (Table 4.4.2, Figure 4.4.3).

Table 4.4.2 Objective lung function change in sub-groups with or without respiratory symptoms and 'high' or 'low' PCL scores

Respiratory symptom at post deployment	PCL score post-deployment	Mean ± S.E.M (N)
No respiratory symptom	Low	80.7 ± 0.3 (88)
	High	80.3 ± 0.7 (17)
More than 1 respiratory symptoms	Low	79.9 ± 0.4 (46)
	High	79.3 ± 0.5 (46)

Data are means FEV1/FVC ± S.E.M (n = number of ADF participants in sub-groups);*P<0.05.

Figure 4.4.3 FEV1/FVC change in sub-groups with or without respiratory symptoms and high or low PCL scores



FEV1/FVC % estimated marginal means across levels of respiratory symptoms and PCL scores P<0.05*.

Table 4.4.1, and Figures 4.4.1 and 4.4.2, have demonstrated the effects of environmental exposures and psychological trauma exposures as possible predictors of change on FEV1/FVC

ratio and self-reported respiratory symptoms at post-deployment. In relation to these findings, the purpose of the following analyses was to further understand if there is a difference between the sub-groups in terms of level of environmental and psychological trauma exposures, and further, whether those ADF members with 'Abnormal' or 'Decreased' lung function, high respiratory symptoms or 'High PCL' have higher mean environmental and psychological trauma exposures compared with the 'Normal', 'Increased', 'No respiratory symptoms' and 'Low PCL' sub-groups.

The results showed that the overall mean of environmental and psychological trauma exposures were somewhat higher in 'Abnormal', 'Decreased', 'High PCL', and 'symptomatic' sub-groups compared to the 'Normal', 'Increased', 'Low PCL' and 'No respiratory symptom' sub-groups respectively, however, this difference was only significant for the high compared to low PCL groups.

Table 4.4.3 Difference between the sub-groups in terms of environmental and psychological trauma exposure at post deployment

	Environmental exposures		**Psychological trauma exposures**	
Sub-groups	[a] Mean ± S.E.M	[b] difference	[a] Mean ± S.E.M	[b] difference
Normal	46.1 ± 1.9 (190)	4.3± 9.6	2.4 ± 0.1 (185)	1.3 ± 0.8
Abnormal	50.5 ± 12.2 (8)		3.7 ± 0.9 (8)	
Increased	49.7 ± 2.7 (78)	-1.5 ± 3.5	2.3 ± 0.2 (78)	-0.2 ± 0.3
Decreased	51.3 ± 2.3 (98)		2.5 ± 0.2 (95)	
Low PCL	48.8 ± 1.8 (134)	-8.6 ± 4.0*	2.1 ± 0.2 (131)	-1.1 ± 0.3**
High PCL	57.5 ± 3.9 (43)		3.3 ± 0.3 (41)	
No symptoms	44.5 ± 2.4 (118)	-6.3 ± 3.8 ^	2.5 ± 0.2 (116)	0.0 ± 0.3
Symptomatic	50.9 ± 2.9 (77)		2.4 ± 0.2 (74)	

[a] Data are mean ± SEM, n = number of ADF participants in sub-groups at post deployment. [b] Mean difference between sub-groups ± SEM difference, *significant $p<0.05$, **$p<0.001$

4.5 Discussion

Following on from the findings of Chapter 3 which suggested that deployment may increase the risk of adverse respiratory outcomes among a subset of ADF members deployed to the MEAO, this chapter further examined the hypotheses that environmental and psychological trauma exposures independently and combined are associated with adverse respiratory outcomes observed among ADF members deployed to the MEAO. In addition, the role of psychological trauma exposure as a moderator on the relationship between environmental exposure and respiratory function and symptoms was also examined.

Similar to previous international and Australian findings regarding the association between environmental factors experienced on deployment in the Middle East, and adverse respiratory function (11, 21, 36, 37, 39), this study identified a similar pattern for psychological trauma as an independent factor. Findings also showed that the effect of environmental exposures on both objective lung function and self-reported respiratory symptoms was influenced by the level of psychological trauma exposure. To the author's knowledge, this finding is novel as no previous prospective military study has demonstrated the effect of psychological stress as a moderator of association between deployment environmental factors and adverse respiratory outcomes among military members.

The results indicate that environmental and psychological trauma exposures independently and combined have an inversely proportional association with objective lung function whereby when environmental or psychological trauma exposures increased, lung function decreased. Environmental exposures and the interaction between environmental exposures and psychological trauma were also significantly associated with self-reported respiratory symptoms at post-deployment. As expected, increased environmental exposures were associated with increased respiratory symptoms. Further, psychological exposure appears to interact with environmental exposures to influence respiratory symptom outcomes, such that the

association between environmental exposures and respiratory symptoms was stronger when accompanied by higher levels of psychological trauma exposure. These findings suggest that in the case of self-reported symptoms, exposure to psychological trauma alone was not associated with respiratory outcomes. Rather, it is possible that psychological trauma exposure influences how ADF members experience environmental exposures, thereby resulting in effects on perceived respiratory health.

There is extensive evidence for association between psychological trauma and mental disorders such as PTSD with prominent respiratory symptoms (60, 124, 152). This raises questions regarding the effect that psychological symptoms may have on the respiratory function of ADF members and the underlying mechanisms involved (60, 124, 158). Within the ADF population, the incidence of mental disorders has been estimated at 22%, with 8.3% of ADF members meeting criteria for PTSD (131). PTSD is characterised by changes in the hypothalamic–pituitary–adrenal axis and the sympathetic–adrenal–medullary system. It is thought that these alterations can lead to a pro-inflammatory state which may result in structural and functional changes in the respiratory system (60, 65-68, 147). In one US study, PTSD-positive male combat veterans had an increased risk of reporting chronic pulmonary diseases compared to those who were PTSD-negative (158), and in another US study, female veterans were at a 1.6 times higher risk of self-reported asthma than those without PTSD (144).

In the current study, high PCL scores were found to be associated with respiratory symptoms. However, the association between high PCL scores and objective lung function was not significant. In addition, further investigation of the pattern of relations between objective lung function changes in sub-groups with ‘high’ or ‘low’ PCL scores with or without respiratory symptoms did not identify any significant relationship. This suggests that having a high PCL score is unlikely to influence objective lung function in this predominantly young and healthy cohort of the ADF, rather, it may manifest in physiological symptoms such as respiratory

symptoms. Contrary to our findings, Spitzer et al (2011) demonstrated that military personnel with decreased objective parameters of lung function were more likely to exhibit PTSD symptoms as well as respiratory symptoms or vice versa. The authors suggested that inflammation may be the link between trauma exposure and both PTSD and airflow limitations (60, 68). However, the difference between this German study and the current Australian study is the nature of the participants. The study by Spitzer et al. (2011) recruited 20-79-year-olds from a general population in West Pomerania, while the ADF sample was mostly comprised of healthy young men 16-54 years of age. Therefore, it was expected to see minimal changes to their objective respiratory function at post-deployment. Further comprehensive investigation of the ADF cohort is required to investigate the role of inflammation in those with high and low PCL scores and the association with adverse respiratory function.

Another finding of this study is that those with elevated post-traumatic stress symptoms reported more environmental and psychological trauma exposures, consistent with the possibility of a link between these exposures and increased respiratory symptoms. There is a commonly proposed mechanism for this association: both environmental and psychological trauma exposures may effect respiratory function via changes in the immune system. These associations may be via direct actions that initiate local and systemic inflammation by stimulation of epithelial cells and alveolar macrophages by particulate matter, leading to respiratory symptoms. Another possible pathway may involve excessive pro-inflammatory responses to acute psychological stress that may result in airway damage and consequently structural and functional pulmonary changes (19, 48-51, 53, 60, 68, 100, 101, 107, 108, 111, 113). Therefore, presumably, higher levels of stress during deployment may, in part, explain the small decrease in objective lung function and increased rate of respiratory symptoms reported among ADF members (53, 106, 108). However, testing this mechanism was beyond the scope of this thesis.

The results from this study together with the international findings indicate that while deployment appears to be associated with adverse respiratory outcomes, this cannot be exclusively attributed to environmental exposures. Other deployment factors such as psychological trauma exposure in the combat environment should also be considered. Overall, the documented associations in this study were small, and deployment-related respiratory conditions have been shown to be subtle. This was expected, as abnormalities in lung function are often present in the sub-syndromal form among an otherwise healthy population (152, 154). Therefore, careful evaluation is required over time to determine the long-term impacts of deployment on syndromal respiratory diseases, as has previously been described for ADF members with self-reported psychological distress (154).

While the associations between stress-related mental disorders such as PTSD and altered immune responses is not causative, low level inflammation and altered immune responses provide plausible mechanisms by which psychological trauma exposure may be associated with respiratory symptoms (53, 60, 124, 144, 152, 158). Further analyses, of this prospective study dataset, are needed to clarify the role of inflammatory mediators in relation to psychological trauma exposures among those ADF with prominent respiratory symptoms.

The findings of this study are of importance to the ADF, providing evidence that deployment exposures and subtle adverse respiratory outcomes should be a focus of clinical intervention and assessment of individuals at risk, post deployment, in order to reduce future respiratory burden.

One limitation in this study includes self-reporting for respiratory symptoms potentially leading to misdiagnosis of the symptoms or under-reporting due to reluctance to report diseases regarding career consequences. The self-report questionnaire recorded up to 4 months after deployment which made it open to recall bias, particularly when data are collected well after

symptoms/conditions have occurred (54, 106). The above-mentioned limitations may result in lower reported rates of respiratory symptoms, environmental and psychological exposures and may minimise associations between exposures and FEV1/FVC and self-reported respiratory and PTSD symptoms.

Another limitation of this study was using a default Listwise deletion for analyses in SPSS which did not include cases that have missing values on the variables under analysis. This led to loss of data due to the exclusion of subjects from the analysis if they were missing data for any variable in that analysis.

Some participant's data were not included in the final analyses due to non-reproducible recordings, coughing or shortness of breath. The resultant small numbers of participants in sub-groups did not provide sufficient power to detect statistically significant differences.

This study is the first to provide detailed investigation of the effects of individual and combined environmental, psychological trauma and other deployment factors on the respiratory health of Middle East deployed ADF members. In addition to international studies suggesting that environmental exposures may be associated with reports of respiratory symptoms, this study also included psychological trauma exposures.

4.6 Conclusion

The findings from this chapter and those from recent studies suggest that environmental exposures are a risk factor for adverse respiratory outcomes within the military population. Exposure to psychological trauma has also been shown to impose additional effects that seem to be synergistic with environmental exposures. The findings from this study support the hypothesis that environmental and psychological trauma exposures independently and

combined have adverse effects on self-reported respiratory symptoms and objective respiratory measures in a cohort of MEAO deployed ADF members. This study has also shown that apart from the direct effect of trauma exposure on adverse respiratory outcomes, psychological trauma may increase the impact of environmental exposures leading to a negative shift in both objective and subjective respiratory outcomes.

Since this study found an association between higher PCL scores and respiratory symptoms and not objective lung function, there is a possibility that psychological distress in the deployment environment may manifest in respiratory symptoms, explaining the association between apparent somatisation and psychological exposures. While the results showed some statistically significant effects, these were not necessarily large, and this is mainly assumed to be related to the general good health of ADF members and the small sample size within the sub-groups. These results are similar to the GW1 findings reporting on somatic manifestation of distress without actual significant objective impact (This has been discussed in more detail in chapter 1).

Low level inflammation and altered immune responses provide plausible mechanisms by which psychological trauma exposure may be associated with adverse respiratory outcomes .Further analyses of this prospective study are needed to clarify the role of inflammatory mediators in relation to psychological trauma exposures among those ADF with prominent respiratory outcomes.

Chapter 5 – Discussion

5.1 Summary

In light of findings from the existing literature discussed in previous chapters of this thesis, the overall objective of this thesis was to understand how deployment may impact on respiratory health outcomes in military populations. The aims of this study were to first investigate if, similar to the reported international literature, there was an increase in subjective respiratory symptoms (self-reported respiratory symptom measured by questionnaire) of ADF members from pre- to post-deployment to the MEAO between 2010 and 2012 and whether these were accompanied with changes in objective function (FEV1/FVC measured by spirometry). The second aim was to examine the predictors of adverse respiratory outcomes among this cohort in the context of combat environmental and psychological trauma exposures.

To investigate the aims, a systematic review of the literature was undertaken to inform the current thesis analysis approach and key factors of interest. Next, this study examined how respiratory health changed from pre- to post-deployment in a subset sample of ADF members deployed to the MEAO from 2010 to 2012. Building on the findings previously reported by Davy et al. (2012), this study then examined the role of exposures more specifically, including a focus on environmental exposures and the contribution of psychological factors (trauma exposures and PTSD symptoms) to the respiratory health of ADF members.

A major contribution of this study was to identify if psychological trauma exposures are associated with negative respiratory health outcomes, in the short-term, following deployment to the MEAO. To the author's knowledge, this is the first Australian prospective study to investigate the effect of psychological trauma exposures on respiratory health outcomes and whether psychological responses to deployment exposures moderate associations between environmental exposures and respiratory health outcomes of ADF members.

By investigating how respiratory health changed from pre- to post deployment in a subset sample of contemporary ADF members deployed to the MEAO from 2010 to 2012, and by examining the role of exposures, including a focus on environmental exposures and the contribution of psychological factors to respiratory health of ADF members, this thesis provided a deeper insight into how the deployment may impact respiratory health outcomes in military populations.

While the majority of individuals were still within the normal range of objective respiratory function (i.e. their FEV1/FVC measures were greater than 70% according to the GOLD standard cut off for Normal respiratory function (135, 136)), this study established evidence of small negative changes in respiratory function in both subjective and objective respiratory measures from pre- to post-deployment among a subset sample of contemporary ADF members deployed to the MEAO between 2010 and 2012. In addition, environmental and psychological trauma exposures were independently associated with adverse respiratory outcomes on both objective and self-report measures. Importantly, there was also a significant interaction, with associations between environmental exposures and both objective and self-reported respiratory measures; stronger under conditions of high compared to low psychological trauma exposure.

The subtle negative changes in respiratory function were expected among this healthy population. Even though these changes were statistically significant, they were small and probably clinically unimportant. In order to determine if the associations between these small changes in respiratory function and deployment exposures are meaningful, careful, ongoing objective and subjective monitoring of this population is required to determine the long-term impacts of deployment on syndromal respiratory conditions.

Section 5.1.1 of this chapter will discuss the findings of this study regarding changes in respiratory function among ADF personnel deployed to the MEAO from pre- to post-

deployment between 2010 and 2012 and section 5.1.2 will discuss the impacts of deployment exposures on adverse respiratory outcomes.

5.1.1 Changes in respiratory function among ADF personnel deployed to the MEAO from pre- to post-deployment between 2010 and 2012

International and Australian GW1 as well as Iraq and Afghanistan conflict (since 2001) studies have documented an increase in the incidence of reported respiratory symptoms among military members during and following deployment to the Middle East (5, 7-12, 25, 44, 45). An important concern for military members is that these symptoms may be suggestive of early onset of potentially serious diseases, such as asthma, bronchitis and COPD (10, 13-15, 60). However, there is a paucity of prospective studies regarding the level of respiratory distress and evidence regarding potential factors leading to adverse respiratory outcomes in military members post-deployment to the Middle East.

Chapter 3 of this thesis investigated if, in congruence with the reported international literature, there was an observable decline in the objective respiratory function and subjective respiratory function of ADF members from pre- to post-deployment.

Building on previous studies, the current study found significant changes in both the objective and subjective respiratory function of contemporary ADF members deployed to the MEAO.

Examination of the ‘Normal’ and ‘Abnormal’ sub-groups showed that while there are health restrictions in place for ADF enrolment (i.e. the ADF has historically precluded asthmatics from particular services or service roles), this study found that 4% met the global initiative for airway obstruction (FEV1/FVC <70%) at pre-deployment. This number increased to 4.5% at post-deployment. Deployment of ADF members with sub-optimal respiratory function may be the

result of less stringent recruitment procedures, compared to the UK and US military recruitment process (34, 149).

Further analysis of the 'Abnormal' subgroups showed that from the total 9 (4.5%) 'Abnormal' cases identified at post-deployment, 4 (2%) had 'Abnormal' respiratory function results at both pre- and post-deployment, while 5 (2.5%) were new cases of 'Abnormal' respiratory function at post-deployment. Although these changes are small, the increase in new cases of abnormal respiratory function could be an indication of possible deployment risk factors influencing adverse respiratory outcome. These sub-threshold respiratory abnormalities and symptoms do not usually result in a reduction in ability to pass military fitness testing. However, early identification of respiratory distress in military members may prove useful in determining strategies for prevention of adverse respiratory outcomes and aids earlier intervention, including recruitment guidelines, such as those followed by the US and UK.

Although the overall increase in sum of self-reported respiratory symptoms among ADF members was not significant, further analysis of the number of respiratory symptoms within this cohort showed that the proportion of ADF members who reported 3 and 4 respiratory symptoms had significantly increased from pre- to-post deployment. This is in line with increased reporting of respiratory symptoms in both the GW1 and the Iraq and Afghanistan conflict (5-9, 31, 151, 152).

Previous military studies, i.e. GW1 studies, were generally limited by a lack of prospective design, meaning that it was not possible to determine the timing of onset of symptoms. However, the MEAO prospective study allowed determination of whether respiratory symptoms do in fact precede or follow deployment. The current study examined the development of respiratory symptoms at post-deployment in those who were symptom-free prior to their deployment.

The analysis addressed which respiratory function sub-groups had a significant increase in incidence of newly reported respiratory symptoms at post-deployment as well as whether or not new respiratory symptoms at post-deployment reflect clinical diagnosis guidelines using the GOLD standard cut off of 70% for FEV1/FVC. The result showed a significant increase in incidence of newly reported respiratory symptoms within the sub-group with decreased objective respiratory function at post-deployment. This is further supported by the significant association observed between overall increase in respiratory symptoms and decrease in objective respiratory function.

In the other sub-groups 'Normal', 'Abnormal', and 'Increased', respiratory function also showed an increase in incidence of newly reported symptoms. Although these increases were not significant, it is notable that even though the sub-group with 'Normal' objective respiratory function met the criteria for being clinically healthy, some participants in this sub-group were symptomatic. The presence of respiratory symptoms within the 'Normal' respiratory function group could suggest that symptoms per se might not necessarily be a reflection of clinically abnormal diagnosis. Instead it may be the result of decrease in objective respiratory function. This has been demonstrated in the current study as the results have shown a significant ($p=0.02$) increase in incidence of newly reported respiratory symptoms within the sub-group with decreased objective respiratory function at post-deployment.

In addition to establishing evidence of change in objective and subjective measures of respiratory function, this study also found that respiratory function as measured by the FEV1/FVC ratio and sum of self-reported respiratory symptoms, between pre-and post-deployment, was not influenced by age, sex, service, prior deployment or current smoking status. This suggests that an increased risk of adverse respiratory outcomes may involve more specific exposures during deployment, such as environmental particulate matter or the

psychological stress of deployment, additional to the characteristics of ADF members or deployment alone.

Given the healthy state of military members at recruitment, existing research suggests that exposures such as environmental (particulate matter, metal particles, burn pit, air pollution), combat stress, and other exposures (physical activity, military living conditions and smoking) might be related to impairments in respiratory function among military members (11, 20, 25, 28, 57, 60, 152).

As suggested by other studies, alterations in the autonomic and/or immune systems (124, 127, 128), possibly following environmental and psychological exposures or a psychological condition such as PTSD, may be possible underlying mechanisms involved in adverse respiratory outcomes observed in this study (27, 124, 127, 128).

The possibility of somatisation and self-reported symptoms reflecting mental distress rather than any actual physical impairment also remains (9). There are suggestions that asymptomatic and undiagnosed conditions may be underestimated. Aggravation of these sub-threshold and mild pre-existing conditions by deployment risk factors such as environmental and psychological exposures may result in worsening of conditions and eventually clinically diagnosable disease or condition. Therefore, deployment could possibly be exacerbating, rather than causing the condition (106, 153). Nevertheless, to make robust statements regarding linkage between deployment exposures, psychological conditions, and immune changes with adverse respiratory outcomes, further physiological and psychological investigations of the ADF members and various exposures in this cohort are required.

The finding of the current study regarding increased respiratory symptom reporting, supports the findings of previous cross-sectional studies (3, 5-7, 9, 21, 31, 40, 45, 60). Despite similar

findings between the different studies reporting high incidence of adverse respiratory function (3, 5-7, 9, 21, 31, 40, 45, 60), it is not possible to determine whether the higher rates of self-reported respiratory symptoms and reduced respiratory function were due to a higher occurrence of new respiratory conditions, somatisation, higher baseline prevalence, or reporting, selection, or confounding bias.

Many of the conclusions of other epidemiological studies of military respiratory health have been based solely on self-reported findings of questionnaire surveys. The use of spirometry tests in our study has provided objective data which provides more valid and reliable results. In addition, given the strengths of a prospective study with known base-line information, including descriptive, self-reported symptoms and objective data, this study demonstrates that there are some significant subtle decreases in both objectively assessed and self-reported respiratory function and symptoms following deployment. Bearing in mind that deployment-related respiratory symptoms and conditions were expected to be subtle and that abnormalities in respiratory function may have presented in a sub-syndromal form among otherwise healthy populations. In order to determine how meaningful these small changes and patterns are, careful evaluation of this cohort is required over time to determine the long-term impacts of deployment on syndromal respiratory conditions.

This study established limited evidence of change in respiratory function via both subjective and objective respiratory measures from pre- to post-deployment among a subset sample of MEAO deployed ADF members between 2010 and 2012. Although the overall analyses of this cohort as a whole showed little decline in both objective and subjective respiratory function post-deployment, further investigation of ‘Normal’ and ‘Abnormal’ respiratory function sub-groups showed significant changes in both objective and subjective respiratory function. Psychological trauma exposures or conditions such as PTSD may be the influencing factors on respiratory function via changes in the autonomic and immune systems (as discussed in the

introduction to this thesis). Furthermore, the possibility of somatisation reflecting mental distress rather than any actual respiratory impairment also remains.

Early identification of potential underlying differences in affected and non-affected ADF members may prove useful in determining strategies for prevention of adverse respiratory outcomes and aid earlier intervention, including recruitment guidelines, such as those followed by the US and UK. These results, together with investigation of possible risk factors, may contribute significantly to long term respiratory health outcomes of the deployed ADF population. For this reason, Chapter 4 of this thesis aimed to examine predictors of adverse respiratory health in the context of combat environmental and psychological trauma exposures among the same cohort of Middle East deployed ADF members.

5.1.2 The impacts of deployment exposures on adverse respiratory outcomes of ADF members deployed to the MEAO between 2010 and 2012

Previous studies indicated that deployment has adverse psychological and physiological effects on ADF members which can last for significant periods post-deployment, such as PTSD, asthma, chronic bronchitis and shortness of breath (3, 40, 71, 131, 133, 134, 152, 154, 159). The significance of examining health concerns is emphasized by consistent findings from post-deployment studies of personnel deployed in support of the GW1 which showed increased reporting of all somatic symptoms, including respiratory symptoms, by GW1 veterans compared with non-GW1 comparison groups (5-8).

As yet, in both the GW1 and the Iraq and Afghanistan conflicts, no specific association has been established between particular MEAO exposures and adverse respiratory outcomes, or the onset of serious disease, despite extensive epidemiological research (5, 12, 16, 17). Because of the limitations in standardising exposure measures, cross-sectional study designs, retrospective

medical review and the self-reported nature of measures in many studies, it is difficult to reach strong conclusions regarding any potential relationship between deployment exposures and adverse respiratory outcomes. However, despite equivocal findings, the current literature suggests that increases in adverse respiratory outcomes among military members following deployment to the MEAO may be associated with exposure to environmental factors (10-12, 20-24). In regards to adverse respiratory outcomes, exposure to psychological trauma has been less investigated than environmental exposures, but remains an important factor that may contribute to impairment in respiratory function (26-28, 46, 47). There is also a common proposed mechanism for this association: both environmental and psychological trauma exposures may affect respiratory function via changes in the immune system.

While environmental exposure has a local inflammatory effect, directly on the lung, psychological exposures induce a systemic inflammatory response that can affect the respiratory system systemically.

Although examining immunological changes regarding adverse respiratory outcomes and possible links with deployment exposures was beyond the scope of the current study, this was discussed both in the background section of Chapter 1, and the discussion in Chapter 4 as there is the possibility that immune changes influence respiratory outcomes via effects of environmental and psychological exposures.

Following on from the findings of Chapter 3, which suggested that deployment may increase the risk of adverse respiratory outcomes among a subset of ADF members deployed to the MEAO, Chapter 4 further examined the hypotheses that environmental and psychological trauma exposures independently and combined are associated with adverse respiratory outcomes observed among ADF members deployed to the MEAO. In addition, the role of psychological trauma exposure as a moderator on the relationship between environmental exposure and FEV1/FVC or respiratory symptoms was also examined.

Similar to previous international and Australian findings regarding the association between environmental factors experienced on deployment in the Middle East, and adverse respiratory function, (11, 36, 37, 39) this study identified psychological trauma as an independent factor. Findings also showed that the effect of environmental exposures on both objective lung function and self-reported respiratory symptoms was influenced by the level of psychological trauma exposure. To the author's knowledge, this finding is novel as no previous prospective military study has demonstrated the effect of psychological stress as a moderator of association between deployment environmental factors and adverse respiratory outcomes among military members.

The results showed that environmental and psychological trauma exposures independently and combined have an inversely proportional association with FEV1/FVC i.e. when environmental or psychological trauma exposures increased, the FEV1/FVC decreased. Environmental exposure and the interaction between environmental exposures and psychological trauma were also significantly associated with self-reported respiratory symptoms at post-deployment. Similar to the findings of previous studies (11, 36, 37, 39), it was expected to see an association between increased environmental exposures with increased respiratory symptoms at post-deployment. In addition, psychological exposure appeared to interact with environmental exposures and influenced respiratory symptom outcomes, such that the association between environmental exposures and respiratory symptoms was stronger when accompanied by higher levels of psychological trauma exposure. The findings suggest that, in the case of self-reported symptoms, exposure to psychological trauma alone was not associated with respiratory outcomes. Rather, it is possible that psychological trauma exposure influences how ADF members experience environmental exposures, thereby resulting in effects on perceived respiratory health.

Further, there is also extensive evidence for association between psychological trauma and mental disorders such as PTSD with prominent respiratory symptoms (60, 124, 152). This raises questions regarding the effect that psychological symptoms may have on the respiratory function of ADF members and the underlying mechanisms involved (60, 124, 152).

Within the ADF population the incidence of mental disorders has been estimated at 22%, with 8.3% of ADF members meeting criteria for PTSD (131). PTSD is characterised by changes in the hypothalamic–pituitary–adrenal axis and the sympathetic–adrenal–medullary system. It is thought that these alterations lead to a pro-inflammatory state which may result in structural and functional changes in the respiratory system (60, 65-68, 147). In one US study, PTSD-positive male combat veterans had increased reporting of chronic pulmonary diseases compared to those who were PTSD-negative (158), and in another US study, female veterans were at 1.6-fold higher self-reported asthma than those without PTSD (144).

In the current study, high PCL scores (symptom severity score for PTSD) were found to be associated with respiratory symptoms. However, the association between high PCL scores and objective lung function (FEV1/FVC) was not significant. Further, investigation of the pattern of relations between objective lung function changes in sub-groups with 'high' or 'low' PCL scores with or without respiratory symptoms did not identify any significant relationship. This suggests that having a high PCL score is unlikely to influence objective lung function in this predominantly young and healthy cohort of ADF, rather, it may manifest in physiological symptoms including respiratory symptoms. Given the high rate of PTSD within the military population, identifying PTSD-affected individuals with prominent respiratory symptoms but with no objective decline in respiratory function may be a cost-effective way to reduce future respiratory burden by addressing the psychological root of this issue. In addition, this could be useful in terms of identifying those at risk for future recruitment and re-deployment of military members.

Another finding of this study was that those with elevated posttraumatic stress symptoms reported more environmental and psychological trauma exposures, consistent with the possibility of a link between these exposures, PTSD symptoms, and increased respiratory symptoms. A commonly proposed mechanism for these associations is a change in the immune system (this has been discussed in detail in Chapter 1 and 4 of this thesis). High intensity or repeated exposures to environmental factors may lead to chronic respiratory conditions, such as chronic bronchitis or COPD. Another possible pathway may involve excessive pro-inflammatory responses to acute psychological stress that may result in airway damage and consequently structural and functional pulmonary changes (19, 48-51, 53, 60, 100, 101, 107, 111, 159). In such a way, psychological stressors may make the respiratory system more vulnerable to other stressors or exposures. Therefore, higher levels of stress during deployment may, in part, explain the decrease in FEV1/FVC and increased rate of respiratory symptoms reported among ADF members. However, testing this mechanism was beyond the scope of the current study. This understanding might be gained by comprehensive investigation of the levels of deployment exposures, objective measures of respiratory outcomes and circulating inflammatory markers at pre-, during, and post-deployment.

Overall, the documented associations in this study were small and deployment-related respiratory conditions have been shown to be subtle. This was expected, as abnormalities in lung function are often present in the sub-syndromal form among an otherwise healthy population (152, 154). Therefore, careful evaluation is required over time to determine the long-term impacts of deployment on syndromal respiratory diseases, as has previously been described for ADF members with self-reported psychological distress (154).

The findings from this study support the hypothesis that environmental and psychological trauma exposures independently and combined have adverse effects on self-reported respiratory symptoms and objective respiratory measures in a cohort of MEAO deployed ADF members.

This study has also shown that, apart from the direct effect of trauma exposure on adverse respiratory outcomes, psychological trauma may increase the impact of environmental exposures leading to a negative shift in both objective and subjective respiratory outcomes. This may explain why previous military findings did not find associations between environmental exposures (i.e. smoke from oil wells (SMOIL) which were set alight by the Iraqi troops in Kuwait) and objective respiratory decline, despite significant increase in respiratory symptoms (7, 31). Therefore, while deployment appears to be associated with adverse respiratory outcomes, this cannot be exclusively attributed to environmental exposures. Other deployment factors, such as psychological trauma exposure in the combat environment, should also be considered.

While the associations between stress-related mental disorders such as PTSD and altered immune responses is not causative, low level inflammation and altered immune responses provide plausible mechanisms by which psychological trauma exposure may be associated with respiratory symptoms (53, 60, 124, 144, 152, 158). Further analyses of this prospective study are needed to clarify the role of inflammatory mediators in relation to psychological trauma exposures among those ADF with prominent respiratory symptoms. This would be an important future study to provide further objective evidence that deployment exposures may affect respiratory outcomes via changes in the immune system. This may inform future preventative measures, such as objective screening of military members to identify inflammatory markers associated with risk for psychological exposure/conditions and adverse respiratory outcomes leading to a decline in future respiratory burden within military population.

5.2 Strengths and limitations

The main strengths of this study include the prospective design and recruitment from a wide cross-section of units preparing to deploy rather than treatment-seeking populations. While

using this prospective design minimised selection bias, given that the current sample represented only a proportion of ADF members deployed to the Middle East over the study period, with some demographic differences seen between the sample and population (e.g. number of males and females), the results may not be representative. This is an inherent limitation of studying deploying personnel, where the short notice and intensive training associated with deployment precluded the research team from approaching many potential participants(134). In addition, the inclusion of important factors in analyses of respiratory health outcomes of ADF members, such as BMI and physical activities in stressful situations were beyond the scope of this study. This may have led to exclusion of possible confounding factors.

The findings presented in this study are limited due to the fact that only 60-70% of pre-deployment participants completed the pre- and post-deployment data collection, and it is possible that those who only completed pre-deployment or who did not respond at either time point, differed in health or deployment experiences from those who did not participate (3).

Although the scope of this thesis did not allow for the in-depth analyses warranted by such an extensive and valuable dataset, to the author's knowledge this is the first Australian study which has attempted to examine whether psychological responses to deployment exposures moderate the relationship between environmental exposures and respiratory health outcomes. International studies have mainly focused on environmental and psychological trauma exposures in the deployed environment as independent predictors. This study is the first study to provide investigation of effects of individual and combined environmental and psychological trauma exposures on respiratory health of Middle East deployed ADF members.

Previous studies have largely relied on self-reported data or cross-sectional studies, which have several limitations in terms of their reliability and validity. In addition to self-reported respiratory data, this prospective study utilised data from objective spirometry tests pre- and

post-deployment. Objective measures are generally used to increase precision and to validate the self-report measures (160). This has increased the comprehensiveness and objectivity of our assessment over the limited previous research on this subject.

While in conjunction with a respiratory questionnaire, spirometry testing provides a powerful diagnostic tool with adequate sensitivity and specificity, the self-report questionnaire data presented in this study were based on subjective assessments made by the ADF participants. This could be limitation in this study, as self-reporting for respiratory symptoms may have led to misdiagnosing of the symptoms or under-reporting due to participants being reluctant to report diseases regarding career consequences. In addition, the self-report questionnaire recorded up to 4 months after deployment which makes it open to recall bias, particularly when data are collected well after symptoms/conditions have occurred (106). The above-mentioned limitations may result in lower reported rates of respiratory symptoms, environmental and psychological exposures, and may minimise associations between exposures and FEV1/FVC, self-reported respiratory and PTSD symptoms.

Previous studies of military populations are either limited to non-deployed or comparing deployed to non-deployed military personnel. This prospective study followed the same group of deployed ADF members from pre-deployment to post-deployment, which allowed for the clarity of the temporal sequence as well as calculation of incidence. This is important because baseline health status is determined before exposure or condition events occur.

Despite the strength of this prospective design, another limitation of this study was missing data associated with poor spirometry, leading to the exclusion of many participants with completed data pre- and post-deployment. Although exclusion is justified in some cases due to non-reproducible recordings, coughing or shortness of breath, this led to almost half of the respondents' data not being included in the statistical analyses. The resultant small numbers of

participants in sub-groups do not provide sufficient power to detect statistically significant differences.

5.3 Implication

The results provided a good indication of the types of respiratory shifts, i.e. increase in reported respiratory symptoms and decrease in FEV1/FVC ratio, which may occur pre- to post-deployment among ADF personnel deployed to the MEAO, especially given the consistency which is in concurrence with some international studies. Therefore, the findings can be informative in terms of what should be done next regarding further studies into preventative measures.

For deployed personnel who have been exposed to environmental factors such as particulate matter and stressful events during deployment, the recruitment of respiratory symptoms is likely to have important implications for the risk of future respiratory disorder. Therefore, it is important to understand that the minor increase in respiratory symptoms and decrease in objective indications, may tip over at some point into clinically significant symptoms or probable disorders (151, 152).

While the analysis of underlying mechanisms including inflammatory mechanisms may have proved more informative in looking at respiratory function in this particular cohort, it was beyond the scope of this thesis. Nevertheless, the limited findings of this study are of importance to the ADF, providing evidence that deployment exposures and subtle adverse respiratory outcomes may be indicative of psychological conditions or respiratory distress not yet clinically identified. Therefore, in order to prevent future respiratory burden, comprehensive subjective and objective assessment of individuals at risk, post-deployment, should be a focus

of military intervention. Identifying indicators of risk in still healthy individuals allows for mitigation strategies aimed at preventing poor health trajectories.

The value of ADF members is substantial to the Australian government and communities, as well as other countries protected by these highly trained individuals. Therefore, any steps that can maximise the duration of their service life without addition of adverse health outcomes should be a critical priority.

Adverse respiratory outcomes in military personnel, linked with deployment exposures, would highlight the need for a risk management approach to deployment environment. Risk management strategies could focus on reducing exposures, ensuring recovery, and increasing resilience to these risk contributors to minimise adverse respiratory outcomes in vulnerable military personnel.

5.4 Recommendations and Future Research

Preventative measures can be taken to avoid the decline of respiratory functions to minimise the increase or emergence of symptoms post-deployment. One recommendation would be to identify adverse respiratory outcomes by adding specific respiratory questionnaires, such as the one used in this study, together with a complete spirometry at pre- and post-deployment. This will aid in identifying individuals at risk of developing adverse respiratory outcomes over time. In addition, the data obtained could be used for further cohort studies to determine the trajectories of respiratory symptoms among deployed ADF members with and without combat exposures.

The results of this and previous studies highlighted the need for increased monitoring and support services to be provided for individuals in roles involving exposure to psychological

trauma, such as those in combat roles. Therefore, in addition to the support services at post-deployment, the next recommendation is to better prepare Defence personnel at pre-deployment against psychological and environmental exposures, shown to have a negative respiratory effect. This can be achieved through an increase in training and awareness of environmental risk factors and further psychological screening and awareness seminars pre-deployment.
In relation to our findings, all the shifts in respiratory function were small and may not have any clinical significance. Nevertheless, future comprehensive prospective studies with a focus on deployment exposures and respiratory health, including complete objective spirometry and immunological tests, could build on the findings of the current study. The findings from the future comprehensive studies may lead to implementing a structural framework into the conducting of objective and subjective respiratory testing at pre-deployment which would be a cost-effective exercise for the military. Those at risk would be identified and closely monitored during deployment for symptoms to ensure adequate measures are taken in line with occupational health and safety guidelines. These pre-deployment tests can also be an effective preventative measure when looking at re-deployment.

An interesting future study could include a comparison of ADF members who did not show any shift in respiratory symptoms and lung function (the majority) to those who showed a shift (the minority). Similar to the US and UK recruitment restrictions, this information could be used as a preventative measure in the form of changes to recruitment procedures in the ADF, as currently the Australian recruitment rules are less stringent (34).

The ultimate goal of the Australian Department of Defence is to look after the health and wellbeing of its members. The high standard of health and well-being for ADF members pre-deployment is a standard that must be maintained to the highest level possible during and post-deployment as it is crucial for these individuals who defend not only Australia, but also contribute to the security and stability of South East Asia and the Indo-Pacific region. The

findings of this study will be presented in the Australian Military Medicine Association conference and will be made available to all Defence personnel via internal Defence and international publications.

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Appendix 1

Middle East Area of Operations (MEAO) Prospective Health Study Pre-Deployment Questionnaire

CMVH
CENTRE FOR MILITARY & VETERANS' HEALTH

MilHOP
Military Health Outcomes Program

Middle East Area of Operations (MEAO) Prospective Health Study Pre Deployment Questionnaire

Part 1: Brief Deployment History

Part 2: Pre Deployment Health Questionnaire

Part 3: Personality and Resilience Insert

For the purposes of this study, deployment to the Middle East Area of Operations includes:

- Deployment to Iraq or areas supporting operations in Iraq;
- Deployment to Afghanistan or areas supporting operations in Afghanistan.

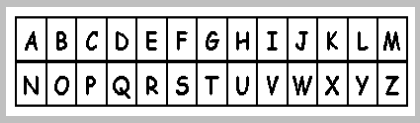
For more information please refer to the instructions on the following page. If you are still uncertain regarding your eligibility to participate in this study, please contact the study team on 1800 232 904 or email cmvh@adelaide.org.au

ID: | | | | | | | | |

Instructions to complete this questionnaire:

This questionnaire asks about your physical and mental health. All information you provide in this questionnaire will be de-identified and will not be linked to other data we have collected about your health without your consent.

Please complete all sections by following the instructions at the beginning of each question. Please **shade circles**, rather than ticking or crossing them, and write clearly and in **capital letters**.



If you make a mistake and wish to change your answer, simply cross out your mistake and choose the answer that is right for you.

Please use **blue or black pen**, not pencil.

Some questions may seem repetitive, but this is necessary due to the questions being grouped into scales.

If you have any questions, please call us on 1800 232 904.

SUPPORT

If you require support in regards to anything in this questionnaire, please refer to the contacts provided below:

ALL HOURS SUPPORT LINE (a confidential telephone triage support service for ADF members and their families)
1800 628 036; outside Australia +61 2 9425 3878

LIFELINE
13 11 14

VETERANS AND VETERANS' FAMILY COUNSELLING SERVICE
1800 011 046

VETERANS' AFFAIRS NETWORK (VAN)
1300 551 918; non-metro 1800 555 254

DEPARTMENT OF VETERANS' AFFAIRS
13 32 54

NATIONAL OFFICE FOR THE MILITARY COMPENSATION AND REHABILITATION SERVICE
1300 550 461

For questions, problems or concerns, or to have your name removed from the mailing list please contact:

THE STUDY TEAM: The Centre for Military and Veterans' Health
Freecall 1800 232 904; cmvh@adelaide.edu.au

FIRST CHIEF INVESTIGATOR: Professor Annette Dobson, University of Queensland
(07) 3365 5346; a.dobson@uq.edu.au

If you prefer to speak to an independent officer of the Universities or Defence Force not involved in the study, you may contact an ethics officer on the numbers listed below:

THE AUSTRALIAN DEFENCE HUMAN RESEARCH ETHICS COMMITTEE
Executive Secretary: (02) 6266 3837; ADHREC@defence.gov.au

THE UNIVERSITY OF ADELAIDE RESEARCH BRANCH
Secretary, Human Research Ethics Committee: (08) 8303 6028

THE DEPARTMENT OF VETERANS' AFFAIRS HUMAN RESEARCH ETHICS COMMITTEE
HREC Coordinator: (02) 6289 6204; ethics.committee@dva.gov.au

Part 1:
Brief Deployment History

Brief Deployment History - MEAO

1.1 Have you been on an ADF operational deployment? (war-like, peacekeeping, peace-monitoring or humanitarian support)

○ Yes ○ No - **please skip to question 1.7**

Instructions: Please indicate which of the following major operations you have been deployed on (*please complete as much of this information as you can*).

1.2 Deployments to MEAO

COUNTRY	OPERATION NAME	YEAR(S) DEPLOYMENT(S) STARTED	NO. OF TIMES DEPLOYED IN YEAR	TOTAL TIME DEPLOYED (MONTHS)
○ Afghanistan or areas supporting operations in Afghanistan	○ OP SLIPPER	○ 2001		
		○ 2002		
		○ 2003		
		○ 2004		
		○ 2005		
		○ 2006		
		○ 2007		
		○ 2008		
		○ 2009		
		○ 2010		

Brief Deployment History - MEAO

COUNTRY	OPERATION NAME	YEAR(S) DEPLOYMENT(S) STARTED	NO. OF TIMES DEPLOYED IN YEAR	TOTAL TIME DEPLOYED (MONTHS)
○ Iraq or areas supporting operations in Iraq	○ OP BASTILLE	○ 2002 ○ 2003		
	○ OP FALCONER	○ 2003		
	○ OP CATALYST	○ 2003 ○ 2004 ○ 2005 ○ 2006 ○ 2007 ○ 2008 ○ 2009		
	○ OP KRUGER	○ 2009 ○ 2010		

Thinking about your most recent deployment to the MEAO:

1.3 Did you feel pressure from your unit to volunteer for this deployment?

- ○ Yes, formal chain of command
- ○ Yes, mates within Unit
- ○ No
- ○ Not applicable

1.4 When you deployed, did you deploy with your parent unit?

- ○ Yes
- ○ No, but I deployed with some members from my Unit
- ○ No, I didn't know anyone I deployed with
- ○ Not applicable, did not have a parent unit

If NO:

a) Did you feel you were treated any differently than members of the host unit?

- ○ No, I was treated the same as the members of the host Unit
- ○ Yes, I was treated better than the members of the host Unit
- ○ Yes, I was treated worse than the members of the host Unit

Brief Deployment History - Other Deployments

1.5 Other Deployments:

COUNTRY	OPERATION NAME	YEAR(S) DEPLOYMENT(S) STARTED	NO. OF TIMES DEPLOYED IN YEAR	TOTAL TIME DEPLOYED (MONTHS)
○ Solomon Islands	○ OP ANODE	○ 2003		
		○ 2004		
		○ 2005		
		○ 2006		
		○ 2007		
		○ 2008		
		○ 2009		
		○ 2010		

Brief Deployment History - Other Deployments

COUNTRY	OPERATION NAME	YEAR(S) DEPLOYMENT(S) STARTED	NO. OF TIMES DEPLOYED IN YEAR	TOTAL TIME DEPLOYED (MONTHS)
○ East Timor	○ InterFET, OP FABER, OP SPITFIRE, OP WARDEN	○ 1999 ○ 2000		
	○ OP TANAGER	○ 2000 ○ 2001 ○ 2002		
	○ OP CITADEL	○ 2002 ○ 2003 ○ 2004		
	○ OP SPIRE	○ 2004 ○ 2005 ○ 2006 ○ 2007		
	○ OP ASTUTE, OP CHIRON, OP TOWER	○ 2005 ○ 2006 ○ 2007 ○ 2008 ○ 2009 ○ 2010		

Brief Deployment History - Other Deployments

COUNTRY	OPERATION NAME	YEAR(S) DEPLOYMENT(S) STARTED	NO. OF TIMES DEPLOYED IN YEAR	TOTAL TIME DEPLOYED (MONTHS)
○ Bougainville	○ OP BEL ISI I	○ 1997		
		○ 1998		
	○ OP BEL ISI II	○ 1999		
		○ 2000		
		○ 2001		
		○ 2002		
		○ 2003		

1.6 What other Operations have you been deployed on (war like, peacekeeping, peace-monitoring or humanitarian support), including UN missions (e.g. OP Palate, OP Riverbank), Humanitarian Missions (e.g. OP Pakistan Assist, OP Sumatra Assist), secondments to foreign militaries (e.g. OP Enduring Freedom, OP Herrick), and border protection (e.g. Op Resolute)? If you have depolyed on more than 10 other Operations, please enter your 10 longest.

COUNTRY	OPERATION NAME	YEAR DEPLOYMENT STARTED	NO. OF TIMES DEPLOYED IN YEAR	TOTAL TIME DEPLOYED (MONTHS)

Brief Deployment History

1.7 Have you worked in the Middle East in a role outside of the ADF (e.g. as a security contractor or for an NGO)? ○ Yes ○ No

If YES:

COUNTRY (If you do not remember or do not wish to report this please write NA)	COMPANY NAME (If you do not remember or do not wish to report this please write NA)	YEAR STARTED	NO. OF TIMES WORKED IN THIS LOCATION IN YEAR	TOTAL TIME WORKED IN THIS LOCATION (MONTHS)

Part 2:
Pre-deployment
Health Questionnaire

Section One: Background Details

1.1 What is today's date? (dd/mm/yyyy) ☐☐ / ☐☐ / ☐☐☐☐

1.2 Are you male or female? ○ Male ○ Female

1.3 What is your date of birth? (dd/mm/yyyy) ☐☐ / ☐☐ / ☐☐☐☐

1.4 Are you currently in a significant intimate relationship?

○ Yes - go to question 1.4a
○ No - go to question 1.4b

1.4a Are you:

○ Married and living together
○ Married with unaccompanied spouse (i.e. married partner currently lives elsewhere)
○ Living with partner (ADF recognised)
○ Living with partner (not ADF recognised)
○ In a long term relationship but not living together

1.4b Are you:

○ Never married
○ Previously married but now divorced
○ Previously married but now separated
○ Other, please specify:

1.5 Were you in a significant intimate relationship ONE YEAR AGO?

○ Yes - go to question 1.5a
○ No - go to question 1.5b

1.5a Were you:

○ Married and living together
○ Married with unaccompanied spouse (i.e. married partner currently lives elsewhere)
○ Living with partner (ADF recognised)
○ Living with partner (not ADF recognised)
○ In a long term relationship but not living together

1.5b Were you:

○ Never married
○ Previously married but now divorced
○ Previously married but now separated
○ Other, please specify:

1.6 How satisfied are you with your marriage / relationship?

○ Extremely satisfied
○ Satisfied
○ Neither satisfied or dissatisfied
○ Dissatisfied
○ Extremely dissatisfied
○ Not applicable

1.7 Have you or your spouse / partner ever seriously suggested the idea of divorce or permanent separation within the LAST YEAR? ○ Yes ○ No ○ Not applicable

Section One: Background Details

1.8 Overall, what impact have your military commitments (now, or in the past if you have left the military) had on your:

a) Marriage / relationship?
- ○ No impact
- ○ Positive impact
- ○ Negative impact
- ○ Not applicable

b) Children?
- ○ No impact
- ○ Positive impact
- ○ Negative impact
- ○ Not applicable

1.9 Which category best describes the highest educational qualification you have completed? Choose one.
- ○ Primary school
- ○ Secondary school up to grade 10
- ○ Secondary school grades 11-12
- ○ Certificate (trade, apprenticeship, technicians etc)
- ○ Diploma (associate, undergraduate)
- ○ Bachelor degree
- ○ Post-graduate qualification

1.10 How many hours per week are you in paid employment, when you are not on deployment? | | | | hours

1.11 To the nearest year, how long have / had you served with the Australian Defence Force: (if more than 0, but less than 1 year, please enter 1)

a) As a regular? | | years *or* ○ Not applicable

b) As a reservist? | | years *or* ○ Not applicable

1.12 What is your CURRENT rank or what WAS your rank when you left the military?
- ○ Senior Commissioned Officer (CMDR / LTCOL / WGCDR and above)
- ○ Commissioned Officer (LCDR / MAJ / SQNLDR and below)
- ○ Senior Non-Commissioned Officer (PO / SGT and above)
- ○ Junior Non-Commissioned Officer (LS / CPL and below)
- ○ Other ranks (AB / SMN / PTE / LAC / AC or equivalent)

1.13 In the past THREE YEARS, roughly how many months in total have you been away on Operational deployment? (if more than 0, but less than 1 month, please enter 1) | | months

If you are still a member of the regular Australian Defence Force, please go to Section Two.

If you are a Reservist or have discharged from the regular Australian Defence Force, please complete the following questions.

Section One: Background Details

1.14 What year did you discharge from the Regular Australian Defence Force?

or

○ Not applicable, I am a Reservist

1.15 Did you discharge to the Reserves or out of the ADF completely? ○ Reserves ○ Out of ADF ○ Not applicable, I have always been a reservist

1.16 What is your current employment status?

○ Paid employment full-time
○ Paid employment part-time / casual
○ Volunteer / community work
○ Student
○ Home Duties
○ Retired
○ Not working due to ill-health / TPI
○ Unemployed
○ Other, please specify:

1.17 Since you separated from the ADF, have you had a period of unemployment greater than 3 months? ○ Yes ○ No ○ Not applicable

If YES, was this period of unemployment primarily due to health problems? ○ Yes ○ No

If YES, please specify type:

1.18 What is your <u>main</u> source of income now? Choose one.

○ Wage or salary
○ Own business or share in a partnership
○ Age Service pension
○ Invalidity Service Pension
○ Compensation benefit under the VEA
○ Compensation benefit under the SRCA
○ Compensation benefit under the MRCA
○ Other government pension / allowance / benefit
○ Child allowance
○ Superannuation / annuity
○ Dividends / interest / income from investments
○ Other, please specify:

Section Two: Recent Health Symptoms

We would like to know about your health in the past month. Please indicate whether or not you have suffered any of the following symptoms in the past month, and if so, please indicate whether your symptoms were mild, moderate or severe in nature.

In the past month have you suffered from:	NO	YES		
2.1 Chest pain	O No	O Mild	O Moderate	O Severe
2.2 Headaches	O No	O Mild	O Moderate	O Severe
2.3 Rapid heartbeat	O No	O Mild	O Moderate	O Severe
2.4 Irritability / outbursts of anger	O No	O Mild	O Moderate	O Severe
2.5. Unable to breathe deeply enough	O No	O Mild	O Moderate	O Severe
2.6 Faster breathing than normal	O No	O Mild	O Moderate	O Severe
2.7 Feeling short of breath at rest	O No	O Mild	O Moderate	O Severe
2.8 Wheezing	O No	O Mild	O Moderate	O Severe
2.9 Sleeping difficulties	O No	O Mild	O Moderate	O Severe
2.10 Feeling jumpy / easily startled	O No	O Mild	O Moderate	O Severe
2.11 Feeling unrefreshed after sleep	O No	O Mild	O Moderate	O Severe
2.12 Fatigue	O No	O Mild	O Moderate	O Severe
2.13 Double vision	O No	O Mild	O Moderate	O Severe
2.14 Intolerance to alcohol	O No	O Mild	O Moderate	O Severe
2.15 Itchy or painful eyes	O No	O Mild	O Moderate	O Severe
2.16 Rash or skin irritation	O No	O Mild	O Moderate	O Severe
2.17 Skin infections e.g. boils	O No	O Mild	O Moderate	O Severe
2.18 Skin ulcers	O No	O Mild	O Moderate	O Severe
2.19 Shaking	O No	O Mild	O Moderate	O Severe
2.20 Tingling in fingers and arms	O No	O Mild	O Moderate	O Severe
2.21 Tingling in legs and toes	O No	O Mild	O Moderate	O Severe
2.22 Numbness in fingers / toes	O No	O Mild	O Moderate	O Severe
2.23 Feeling distant or cut off from others	O No	O Mild	O Moderate	O Severe
2.24 Constipation	O No	O Mild	O Moderate	O Severe
2.25 Flatulence or burping	O No	O Mild	O Moderate	O Severe

Section Two: Recent Health Symptoms

In the past month have you suffered from:	NO	YES		
2.26 Stomach cramps	○ No	○ Mild	○ Moderate	○ Severe
2.27 Diarrhoea	○ No	○ Mild	○ Moderate	○ Severe
2.28 Indigestion	○ No	○ Mild	○ Moderate	○ Severe
2.29 Dry mouth	○ No	○ Mild	○ Moderate	○ Severe
2.30 Pain in the face, jaw, in front of the ear, or in the ear	○ No	○ Mild	○ Moderate	○ Severe
2.31 Persistent cough	○ No	○ Mild	○ Moderate	○ Severe
2.32 Lump in throat	○ No	○ Mild	○ Moderate	○ Severe
2.33 Sore throat	○ No	○ Mild	○ Moderate	○ Severe
2.34 Forgetfulness	○ No	○ Mild	○ Moderate	○ Severe
2.35 Dizziness, fainting or blackouts	○ No	○ Mild	○ Moderate	○ Severe
2.36 Seizures or convulsions	○ No	○ Mild	○ Moderate	○ Severe
2.37 Feeling disorientated	○ No	○ Mild	○ Moderate	○ Severe
2.38 Loss of concentration	○ No	○ Mild	○ Moderate	○ Severe
2.39 Difficulty finding the right word	○ No	○ Mild	○ Moderate	○ Severe
2.40 Pain on passing urine	○ No	○ Mild	○ Moderate	○ Severe
2.41 Passing urine more often	○ No	○ Mild	○ Moderate	○ Severe
2.42 Burning sensation in the sex organs	○ No	○ Mild	○ Moderate	○ Severe
2.43 Loss of interest in sex	○ No	○ Mild	○ Moderate	○ Severe
2.44 Problems with sexual functioning	○ No	○ Mild	○ Moderate	○ Severe
2.45 Increased sensitivity to noise	○ No	○ Mild	○ Moderate	○ Severe
2.46 Increased sensitivity to light	○ No	○ Mild	○ Moderate	○ Severe
2.47 Increased sensitivity to smells or odours	○ No	○ Mild	○ Moderate	○ Severe
2.48 Ringing in the ears	○ No	○ Mild	○ Moderate	○ Severe
2.49 Avoiding doing things or situations	○ No	○ Mild	○ Moderate	○ Severe
2.50 Pain, without swelling or redness, in several joints	○ No	○ Mild	○ Moderate	○ Severe
2.51 Joint stiffness	○ No	○ Mild	○ Moderate	○ Severe
2.52 Feeling that your bowel movement is not finished	○ No	○ Mild	○ Moderate	○ Severe

Section Two: Recent Health Symptoms

In the past month have you suffered from:	NO	YES		
2.53 Changeable bowel function (mixture of diarrhoea / constipation)	○ No	○ Mild	○ Moderate	○ Severe
2.54 General muscle aches or pains	○ No	○ Mild	○ Moderate	○ Severe
2.55 Loss of balance or coordination	○ No	○ Mild	○ Moderate	○ Severe
2.56 Difficulty speaking	○ No	○ Mild	○ Moderate	○ Severe
2.57 Low back pain	○ No	○ Mild	○ Moderate	○ Severe
2.58 Night sweats which soak the bed sheets	○ No	○ Mild	○ Moderate	○ Severe
2.59 Feeling feverish	○ No	○ Mild	○ Moderate	○ Severe
2.60 Tender or painful swelling of lymph glands in neck, armpit or groin	○ No	○ Mild	○ Moderate	○ Severe
2.61 Loss of, or decrease in, appetite	○ No	○ Mild	○ Moderate	○ Severe
2.62 Nausea	○ No	○ Mild	○ Moderate	○ Severe
2.63 Vomiting	○ No	○ Mild	○ Moderate	○ Severe
2.64 Distressing dreams	○ No	○ Mild	○ Moderate	○ Severe
2.65 Stomach bloating	○ No	○ Mild	○ Moderate	○ Severe
2.66 Unintended weight gain greater than 4kg	○ No	○ Mild	○ Moderate	○ Severe
2.67 Unintended weight loss greater than 4kg	○ No	○ Mild	○ Moderate	○ Severe

Section Two: Recent Health Symptoms

2.68 During your lifetime, did you experience any of the following events?		
Blast or Explosion IED (improvised explosive device)	○ No	○ Yes
RPG (rocket propelled grenade), Land Mine, Grenade, etc.	○ No	○ Yes
Vehicular accident / crash (any vehicle, including aircraft)	○ No	○ Yes
Fragment wound or bullet wound above the shoulders	○ No	○ Yes
Fall	○ No	○ Yes

If NO to all events in 2.68: please skip to question 3.1. Otherwise, continue.

2.69 How many times in total have you experienced each of the following symptoms immediately after any of the events listed above?	
Loss of consciousness / "knocked out"	☐☐ times
Being dazed, confused, or "seeing stars"	☐☐ times
Not remembering the event	☐☐ times
Concussion	☐☐ times
Head injury	☐☐ times

2.70 Did any of the following problems begin or get worse after any of the events listed above?					
Memory problems or lapses	○ No	○ Yes	Irritability	○ No	○ Yes
Balance problems or dizziness	○ No	○ Yes	Headaches	○ No	○ Yes
Sensitivity to bright light	○ No	○ Yes	Sleep problems	○ No	○ Yes

2.71 In the past week, have you had any of these symptoms?					
Memory problems or lapses	○ No	○ Yes	Irritability	○ No	○ Yes
Balance problems or dizziness	○ No	○ Yes	Headaches	○ No	○ Yes
Sensitivity to bright light	○ No	○ Yes	Sleep problems	○ No	○ Yes

Section Three: Your Health Now

This next set of questions ask for your views about your health. This information will help you to keep track of how you feel and how well you are able to do your usual activities.

For each of the following questions, please shade the circle that best describes your answer.

3.1 In general, how would you say your health is? ○ Excellent ○ Very good ○ Good ○ Fair ○ Poor

3.2 The following questions are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?

Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf?	○ Yes, limited a lot	○ Yes, limited a little	○ No, not limited at all
Climbing several flights of stairs?	○ Yes, limited a lot	○ Yes, limited a little	○ No, not limited at all

3.3 During the past 4 weeks, how much of the time have you had any of the following problems with your work or other regular daily activities as a result of your physical health?

	ALL OF THE TIME	MOST OF THE TIME	SOME OF THE TIME	A LITTLE OF THE TIME	NONE OF THE TIME
Accomplished less than you would like	○	○	○	○	○
Were limited in the kind of work or other activities	○	○	○	○	○

3.4 During the past 4 weeks, how much of the time have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)?

	ALL OF THE TIME	MOST OF THE TIME	SOME OF THE TIME	A LITTLE OF THE TIME	NONE OF THE TIME
Accomplished less than you would like	○	○	○	○	○
Did work or other activities less carefully than usual	○	○	○	○	○

3.5 During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and housework)?

○ Not at all ○ A little bit ○ Moderately ○ Quite a bit ○ Extremely

3.6 These questions are about how you feel and how things have been with you during the past 4 weeks. For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the past 4 weeks...

	ALL OF THE TIME	MOST OF THE TIME	SOME OF THE TIME	A LITTLE OF THE TIME	NONE OF THE TIME
Have you felt calm and peaceful?	○	○	○	○	○
Did you have a lot of energy?	○	○	○	○	○
Have you felt downhearted and depressed?	○	○	○	○	○

3.7 During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting friends, relatives etc.)?

○ All of the time ○ Most of the time ○ Some of the time ○ A little of the time ○ None of the time

Section Three: Your Health Now

In general, how would you rate your:	EXCELL-ENT	VERY GOOD	GOOD	FAIR	POOR
3.8 Overall health?	○	○	○	○	○
3.9 Quality of life?	○	○	○	○	○
3.10 Eyesight (with glasses or contact lenses, if you wear them)?	○	○	○	○	○
3.11 Hearing?	○	○	○	○	○
3.12 Memory?	○	○	○	○	○
3.13 Teeth and gums?	○	○	○	○	○

The following questions inquire about how you have been feeling over the last four (4) weeks. Please read each question carefully and then indicate, by shading the circle, the response that best describes how you have been feeling.

	ALL OF THE TIME	MOST OF THE TIME	SOME OF THE TIME	A LITTLE OF THE TIME	NONE OF THE TIME
3.14 In the past four (4) weeks, about how often did you feel tired for no good reason?	○	○	○	○	○
3.15 In the past four (4) weeks, about how often did you feel nervous?	○	○	○	○	○
3.16 In the past four (4) weeks, about how often did you feel so nervous that nothing could calm you down?	○	○	○	○	○
3.17 In the past four (4) weeks, about how often did you feel hopeless?	○	○	○	○	○
3.18 In the past four (4) weeks, about how often did you feel restless or fidgety?	○	○	○	○	○
3.19 In the past four (4) weeks, about how often did you feel so restless that you could not sit still?	○	○	○	○	○
3.20 In the past four (4) weeks, about how often did you feel depressed?	○	○	○	○	○
3.21 In the past four (4) weeks, about how often did you feel that everything was an effort?	○	○	○	○	○
3.22 In the past four (4) weeks, about how often did you feel so sad that nothing could cheer you up?	○	○	○	○	○
3.23 In the past four (4) weeks, about how often did you feel worthless?	○	○	○	○	○

Section Three: Your Health Now

The next few questions are about how these feelings may have affected you in the past four (4) weeks. You need not answer these questions if you answered 'None of the time' to all of the previous ten questions about your feelings.

3.24 In the past four (4) weeks, how many days were you TOTALLY UNABLE to work, study or manage your day to day activities because of these feelings? ☐☐ days

3.25 [Aside from those days], in the past four (4) weeks, HOW MANY DAYS were you able to work or study or manage your day to day activities, but had to CUT DOWN on what you did because of these feelings? ☐☐ days

3.26 In the past four (4) weeks, how many times have you seen a doctor or any other health professional about these feelings? ☐☐ times

3.27 In the past four (4) weeks, how often have physical health problems been the main cause of these feelings?

○ None of the time ○ A little of the time ○ Some of the time ○ Most of the time ○ All of the time

3.28 Please rate the following statements based on how you have felt in the <u>past 30 days</u> using the scale below.

	NOT TRUE AT ALL	RARELY TRUE	SOME-TIMES TRUE	OFTEN TRUE	TRUE NEARLY ALL THE TIME
a) I am able to adapt to change	○	○	○	○	○
b) I tend to bounce back after illness or hardship	○	○	○	○	○

Section Three: Your Health Now

We would like to know if you have ever been diagnosed by a medical doctor and treated in the last 12 months for any of the following medical problems or conditions.

	YES	NO
3.29 High blood pressure	○	○
3.30 Migraines	○	○
3.31 Bowel disorder e.g. diarrhoea, constipation, bleeding	○	○
3.32 Eye or vision problems e.g. glaucoma	○	○
3.33 Hearing loss	○	○
3.34 Malaria	○	○
3.35 Any other significant infections, please specify type:	○	○
3.36 Arthritis or rheumatism	○	○
3.37 Back or neck problems	○	○
3.38 Joint problems	○	○
3.39 Asthma	○	○
3.40 Bronchitis	○	○
3.41 Sinus problems	○	○
3.42 Hay fever	○	○
3.43 Ear infection	○	○
3.44 Dermatitis	○	○
3.45 Any other skin problem, please specify type:	○	○
3.46 Skin cancer e.g. squamous cell or basal cell skin cancers	○	○
3.47 Any other kind of cancer, tumour or malignancy, please specify type:	○	○
3.48 Anxiety, stress or depression	○	○
3.49 Post traumatic stress disorder	○	○

Section Three: Your Health Now

	YES	NO
3.50 Other psychiatric or psychological condition needing treatment or counselling, please specify type:	○	○
3.51 Any other medical condition, please specify type:	○	○

Section Four: Lifestyle Behaviours

4.1 In the past year, have you used any of the following tobacco products?

	NO	YES
a. Cigarettes	○	○
b. Cigars	○	○
c. Pipes	○	○
d. Smokeless tobacco (e.g. chew, dip, snuff)	○	○

4.2 In your lifetime, have you smoked at least 100 cigarettes (5 packs)?

○ No - **please skip to question 4.9**

○ Yes - **continue to next question**

4.3 At what age did you start smoking? ☐☐ years old

4.4 How many years have you, or did you, smoke an average of at least 3 cigarettes per day (or one pack per week)? ☐☐ years

4.5 When smoking, how many packs per day did you, or do you, smoke?

○ Less than half a pack per day
○ Half to 1 pack per day
○ 1 to 2 packs per day
○ More than 2 packs per day

4.6 Have you ever tried to quit smoking?

○ Yes, and succeeded
○ Yes, but not successfully
○ No

4.7 If you have ever deployed, was your smoking pattern different while on deployment?

○ I have never deployed
○ I did not smoke on deployment
○ I smoked less than usual while on deployment
○ I smoked the same amount on deployment as when not deployed
○ I smoked more than usual while on deployment
○ I began / restarted smoking on deployment

4.8 If your smoking pattern changed during your deployment, what was the main reason?

Section Four: Lifestyle Behaviours

4.9. How often do you have a drink containing alcohol?	Never	Monthly or Less	2 to 4 times a month	2 to 3 times a week	4 or more times a week
	○	○	○	○	○

In answering the following questions, please remember that a standard drink contains 10g of pure alcohol

4.10 How many 'standard' drinks (see above) containing alcohol do you have on a typical day when you are drinking?	1 or 2	3 or 4	5 or 6	7 to 9	10 or more	N/A
	○	○	○	○	○	○

	NEVER	LESS THAN MONTHLY	MONTHLY	WEEKLY	DAILY OR ALMOST DAILY
4.11 How often do you have six or more drinks on one occasion?	○	○	○	○	○
4.12 How often during the last 12 months have you found that you were not able to stop drinking once you had started?	○	○	○	○	○
4.13 How often during the last 12 months have you failed to do what was normally expected from you because of drinking?	○	○	○	○	○

Section Four: Lifestyle Behaviours

	NEVER	LESS THAN ONCE A MONTH	MONTHLY	WEEKLY	DAILY OR ALMOST DAILY
4.14 How often during the last 12 months have you needed a drink in the morning to get yourself going after a heavy drinking session?	○	○	○	○	○
4.15 How often during the last 12 months have you had a feeling of guilt or remorse after drinking?	○	○	○	○	○
4.16 How often during the last 12 months have you been unable to remember what happened the night before because you had been drinking?	○	○	○	○	○

4.17 Have you or someone else been injured as a result of your drinking?	No ○	Yes, but not in the last 12 months ○	Yes, during the last 12 months ○
4.18 Has a relative, a friend, a doctor or other health professional been concerned about your drinking or suggested you cut down?	No ○	Yes, but not in the last 12 months ○	Yes, during the last 12 months ○

4.19 Do you presently have a problem with drinking?	No ○	Probably not ○	Unsure ○	Possibly ○	Definitely ○

4.20 In the next 3 months, how difficult would you find it to cut down or stop drinking?	Very easy ○	Fairly easy ○	Neither difficult nor easy ○	Fairly difficult ○	Very difficult ○	N/A ○

4.21 On an average day, how many 250 - 375ml beverages containing caffeine do you drink (such as caffeine containing energy drinks, coffee, tea, coca-cola)?

○ None ○ 1-2 per day ○ 3-5 per day ○ 6-10 per day ○ 11 or more per day

Section Four: Lifestyle Behaviours

4.22 Do you currently take any of the following supplements?

a) Body building supplements (such as amino acids, weight gain products, creatine, etc.)

○ Never ○ Less than once a month ○ Monthly ○ Weekly ○ Daily or almost daily

If YES, what was the name (generic or brand name) of the supplement that you used?

b) Energy supplements (such as energy drinks, pills, or energy enhancing herbs)

○ Never ○ Less than once a month ○ Monthly ○ Weekly ○ Daily or almost daily

If YES, what was the name (generic or brand name) of the supplement that you used?

c) Weight loss supplements

○ Never ○ Less than once a month ○ Monthly ○ Weekly ○ Daily or almost daily

If YES, what was the name (generic or brand name) of the supplement that you used?

In the last 12 months...

	NEVER	SOMETIMES	MOST OF THE TIME	ALMOST ALWAYS
4.23 Have you bet more than you could really afford to lose?	○	○	○	○
4.24 Have you needed to gamble with larger amounts of money to get the same feeling of excitement?	○	○	○	○
4.25 When you gambled, did you go back another day to try to win back the money you lost?	○	○	○	○
4.26 Have you borrowed money or sold anything to get money to gamble?	○	○	○	○
4.27 Have you felt that you might have a problem with gambling?	○	○	○	○
4.28 Has gambling caused you any health problems, including stress or anxiety?	○	○	○	○
4.29 Have people criticized your betting or told you that you had a gambling problem, regardless of whether or not you thought it was true?	○	○	○	○
4.30 Has your gambling caused any financial problems for you or your household?	○	○	○	○
4.31 Have you felt guilty about the way you gamble or what happens when you gamble?	○	○	○	○

Section Five: Life Experiences

Below is a list of problems and complaints that people sometimes have in response to stressful life experiences. Please read each one carefully, then shade the circle to the right to indicate how much you have been bothered by that problem in the past month.

	NOT AT ALL	A LITTLE BIT	MODERA-TELY	QUITE A BIT	EXTREM-ELY
5.1 Repeated, disturbing memories, thoughts or images of a stressful experience from the past?	○	○	○	○	○
5.2 Repeated, disturbing dreams of a stressful experience from the past?	○	○	○	○	○
5.3 Suddenly acting or feeling as if a stressful experience from the past were happening again (as if you were reliving it)?	○	○	○	○	○
5.4 Feeling very upset when something reminded you of a stressful experience from the past?	○	○	○	○	○
5.5 Having physical reactions (e.g. heart pounding, trouble breathing, sweating) when something reminded you of a stressful experience from the past?	○	○	○	○	○
5.6 Avoiding thinking about or talking about a stressful experience from the past or avoiding having feelings related to it?	○	○	○	○	○
5.7 Avoiding activities or situations because they reminded you of a stressful experience from the past?	○	○	○	○	○
5.8 Trouble remembering important parts of a stressful experience from the past?	○	○	○	○	○
5.9 Loss of interest in activities that you used to enjoy?	○	○	○	○	○
5.10 Feeling distant or cut off from other people?	○	○	○	○	○
5.11 Feeling emotionally numb or being unable to have loving feelings for those close to you?	○	○	○	○	○
5.12 Feeling as if your future somehow will be cut short?	○	○	○	○	○
5.13 Trouble falling or staying asleep?	○	○	○	○	○
5.14 Feeling irritable or having angry outbursts?	○	○	○	○	○
5.15 Having difficulty concentrating?	○	○	○	○	○
5.16 Being "superalert" or watchful or on guard?	○	○	○	○	○
5.17 Feeling jumpy or easily startled?	○	○	○	○	○

Section Five: Life Experiences

Below is a list of problems and complaints that people sometimes have in response to stressful life experiences. Please read each one carefully, then shade the circle to the right to indicate how much you have been bothered by that problem in the past month.

	NOT AT ALL	A LITTLE BIT	MODERA-TELY	QUITE A BIT	EXTREM-ELY
5.17a Having strong negative beliefs about yourself, other people, or the world (for example, having thoughts such as: I am bad, there is something seriously wrong with me, no one can be trusted, the world is completely dangerous)?	○	○	○	○	○
5.17b Blaming yourself or someone else severely for the stressful experience or what happened after it?	○	○	○	○	○
5.17c Having strong negative feelings such as fear, horror, anger, guilt, or shame?	○	○	○	○	○
5.17d Taking too many risks or doing things that cause you harm?	○	○	○	○	○

5.18 Thinking of the event(s) that you used to answer questions 5.1 - 5.17d, please list these events and the years they occurred below.

	Event description	Year
1		
2		
3		

5.19 Did this occur while deployed to the MEAO? ○ Yes ○ No

5.20 **If NO**, did this occur during another overseas deployment? ○ Yes ○ No

5.21 Is there any other event that has caused you to have similar reactions?

○ No
○ Yes - while deployed
○ Yes - while NOT deployed

If yes, what was that event?

Year of event

Section Five: Life Experiences

5.22 Thinking over the past 4 weeks, shade the circle that best describes the amount of time you felt that way.

	NONE OF THE TIME	A LITTLE OF THE TIME	SOME OF THE TIME	MOST OF THE TIME	ALL OF THE TIME
a) I found myself getting angry at people or situations	○	○	○	○	○
b) When I got angry, I got really mad	○	○	○	○	○
c) When I got angry, I stayed angry	○	○	○	○	○
d) When I got angry at someone, I wanted to hit them	○	○	○	○	○
e) My anger interfered with my ability to get my work, study or other productive activity done	○	○	○	○	○
f) My anger prevented me from getting along with people as well as I'd have liked to	○	○	○	○	○
g) I became angry at myself when I did not perform as well or achieve what I wanted	○	○	○	○	○
h) I became angry at myself when I did not handle social situations as well as I wanted	○	○	○	○	○
i) My anger had a bad effect on my health	○	○	○	○	○

5.23 How often over the last month did you get into a fight with someone and hit the person?

○ Never ○ One time ○ Two times ○ Three or four times ○ Five or more times

5.24 How often over the last month did you threaten someone with physical violence?

○ Never ○ One time ○ Two times ○ Three or four times ○ Five or more times

Section Five: Life Experiences

Over the last 2 weeks, how often have you been bothered by any of the following problems?

	NOT AT ALL	SEVERAL DAYS	MORE THAN HALF THE DAYS	NEARLY EVERY DAY
5.25 Little interest or pleasure in doing things	○	○	○	○
5.26 Feeling down, depressed, or hopeless	○	○	○	○
5.27 Trouble falling or staying asleep, or sleeping too much	○	○	○	○
5.28 Feeling tired or having little energy	○	○	○	○
5.29 Poor appetite or overeating	○	○	○	○
5.30 Feeling bad about yourself, or that you are a failure, or have let yourself or your family down	○	○	○	○
5.31 Trouble concentrating on things, such as reading the newspaper or watching television	○	○	○	○
5.32 Moving or speaking so slowly that other people could have noticed? Or the opposite - being so fidgety or restless that you have been moving around a lot more than usual	○	○	○	○
5.33 Thoughts that you would be better off dead or of hurting yourself in some way	○	○	○	○

5.34 If you checked off any of these problems, how difficult have these problems made it for you to do your work, take care of things at home, or get along with other people?

○ Not difficult at all ○ Somewhat difficult ○ Very difficult ○ Extremely difficult

The next group of questions are about anxiety.

	NO	YES
5.35 In the last 4 weeks, have you had an anxiety attack - suddenly feeling fear or panic?	○	○
If NO: please skip to question 5.50		
5.36 Has this ever happened before?	○	○
5.37 Do some of these attacks come suddenly out of the blue - that is, in situations where you don't expect to be nervous or uncomfortable?	○	○
5.38 Do these attacks bother you a lot or are you worried about having another attack?	○	○

Section Five: Life Experiences

Think about your last bad anxiety attack.		
	NO	**YES**
5.39 Were you short of breath?	○	○
5.40 Did your heart race, pound, or skip?	○	○
5.41 Did you have chest pain or pressure?	○	○
5.42 Did you sweat?	○	○
5.43 Did you feel as if you were choking?	○	○
5.44 Did you have hot flushes or chills?	○	○
5.45 Did you have nausea or an upset stomach, or the feeling that you were going to have diarrhoea?	○	○
5.46 Did you feel dizzy, unsteady, or faint?	○	○
5.47 Did you have tingling or numbness in parts of your body?	○	○
5.48 Did you tremble or shake?	○	○
5.49 Were you afraid you were dying?	○	○

Over the last 4 weeks, how often have you been bothered by any of the following problems?			
	NOT AT ALL	**SEVERAL DAYS**	**MORE THAN HALF THE DAYS**
5.50 Feeling nervous, anxious, on edge, or worrying a lot about different things	○	○	○
If NOT AT ALL: please skip to question 5.57			
5.51 Feeling restless so that it is hard to sit still	○	○	○
5.52 Getting tired very easily	○	○	○
5.53 Muscle tension, aches, or soreness	○	○	○
5.54 Trouble falling asleep or staying asleep	○	○	○
5.55 Trouble concentrating on things, such as reading a book or watching TV	○	○	○
5.56 Becoming easily annoyed or irritable	○	○	○

Section Five: Life Experiences

Please shade the circles that best describe your experience.		
5.57 In the last 12 months, have you ever felt that life was not worth living?	○ No	○ Yes
5.58 In the last 12 months, have you ever felt so low that you thought about committing suicide?	○ No	○ Yes
5.59 In the last 12 months, have you made a suicide plan?	○ No	○ Yes
5.60 In the last 12 months, have you attempted suicide?	○ No	○ Yes

If you require support in relation to any issues you have identified in this survey, we encourage you to refer to the contacts provided on Page 3.

Section Six: Your Respiratory Health

The following questions ask you about any respiratory symptoms you may have experienced in the past 12 months.		
	NO	**YES**
6.1 Have you had wheezing or whistling in your chest at any time in the last 12 months?	○	○
If YES:		
a. Have you been at all breathless when the wheezing noise was present?	○	○
b. Have you had this wheezing or whistling when you did not have a cold?	○	○
6.2 Have you woken up with a feeling of tightness in your chest at any time in the last 12 months?	○	○
6.3 Have you been woken by an attack of shortness of breath at any time in the last 12 months?	○	○
6.4 Have you been woken by an attack of coughing at any time in the last 12 months?	○	○
6.5 Have you had an attack of asthma in the last 12 months?	○	○
6.6 Are you currently taking any medicine for asthma (including inhalers, aerosols, or tablets)?	○	○
6.7 Do you have any nasal allergies including hay fever?	○	○

Section Seven: Your Reproductive History

7.1 Have you and your partner (current or previous) ever had problems with infertility (tried to get pregnant for more than 12 consecutive months without success)?

- ○ Never tried to get pregnant - **please skip to Section Eight**
- ○ No problem with infertility - **please skip to question 7.3**
- ○ Yes

If YES:

7.2 In what year did you recognise you had infertility problems? | | | | |

7.3 Have you ever been pregnant or fathered a pregnancy (including miscarriages, ectopics or terminations)?

- ○ Yes
- ○ No - **please skip to Section Eight**

If YES:

7.4 Please answer the following questions for each of your pregnancies (if you have had more than 4 pregnancies, please phone the study team on 1800 232 904). For pregnancies involving twins, triplets or more, use a separate column for each baby.

		1st Pregnancy	2nd Pregnancy	3rd Pregnancy	4th Pregnancy
What was the outcome of this pregnancy?	Live birth	○	○	○	○
	Live birth but baby died within 28 days of birth	○	○	○	○
	Still birth	○	○	○	○
	Ectopic pregnancy	○	○	○	○
	Miscarriage	○	○	○	○
	Termination (abortion)	○	○	○	○
	Currently pregnant	○	○	○	○
Approximate date of pregnancy outcome		d d m m y y	d d m m y y	d d m m y y	d d m m y y
How many weeks was the pregnancy? (Full term = 40 wks)	Less than 20	○	○	○	○
	20 or more but less than 37	○	○	○	○
	37 or more (inc. full term)	○	○	○	○

Section Seven: Your Reproductive History

		1st Pregnancy	2nd Pregnancy	3rd Pregnancy	4th Pregnancy
If this pregnancy resulted in a birth, what was your baby's sex?	Male	○	○	○	○
	Female	○	○	○	○
	Not applicable	○	○	○	○
If this pregnancy resulted in a birth, what was your baby's birth weight?		lbs oz *or* g *or:* ○ Can't remember ○ Not applicable	lbs oz *or* g *or:* ○ Can't remember ○ Not applicable	lbs oz *or* g *or:* ○ Can't remember ○ Not applicable	lbs oz *or* g *or:* ○ Can't remember ○ Not applicable
Did the baby have any birth defects?	Yes	○	○	○	○
	No	○	○	○	○
	Not applicable	○	○	○	○
If this pregnancy resulted in a live birth, has the child ever suffered from cancer?	Yes	○	○	○	○
	No	○	○	○	○
	Not applicable	○	○	○	○

Section Eight: Recreation and Social Activities

Please answer the following questions regarding your recreation and social activities.

How often do you…

	EVERY DAY	SEVERAL TIMES PER WEEK	WEEKLY OR FORT-NIGHTLY	MONTHLY	RARELY OR ON SPECIAL OCCASIONS	NEVER
8.1 Have contact with an ex-service organisation?	O	O	O	O	O	O
8.2 Have social contact with other veterans?	O	O	O	O	O	O
8.3 Have contact with friends or relatives?	O	O	O	O	O	O
8.4 Attend social activities such as watching sport, eating meals or watching movies?	O	O	O	O	O	O
8.5 Play sport (e.g. golf, fishing, exercise)?	O	O	O	O	O	O
8.6 Set aside time to do a hobby (e.g. wood work, craft, music)?	O	O	O	O	O	O
8.7 Set aside time to relax (e.g. watch TV, read, listen to music)?	O	O	O	O	O	O
8.8 Do voluntary work?	O	O	O	O	O	O

8.9 Do you commemorate significant military-related occasions such as attend ANZAC Day services, participate in marches or attend dawn services?	O Yes	O No
8.10 Do you know of other service veterans living near you?	O Yes	O No
8.11 Are any of your close relatives (parents, siblings) military veterans?	O Yes	O No

Section Nine: Evaluation Questions

9.1 Are there other important health concerns we have not asked you about? ○ Yes ○ No

If **YES**: please give details in the space provided

9.2 Do you have any additional comments you would like to add? ○ Yes ○ No

If **YES**: please give details in the space provided

You are 2/3 of the way through. Keep going!

Part 3: Pre-deployment Personality and Resilience Insert

Section One: Personality

Here are a number of personality traits that may or may not apply to you. For each statement, shade the circle that indicates the extent to which you agree or disagree with that statement.

Rate the extent to which the pair of traits applies to you, even if one characteristic applies more strongly than the other.

	DISAGREE			NEITHER AGREE NOR DISAGREE	AGREE		
	STRONGLY	MODERATELY	A LITTLE		A LITTLE	MODERATELY	STRONGLY
1.1 Extraverted, enthusiastic	○	○	○	○	○	○	○
1.2 Critical, quarrelsome	○	○	○	○	○	○	○
1.3 Dependable, self-disciplined	○	○	○	○	○	○	○
1.4 Anxious, easily upset	○	○	○	○	○	○	○
1.5 Open to new experiences, complex	○	○	○	○	○	○	○
1.6 Reserved, quiet	○	○	○	○	○	○	○
1.7 Sympathetic, warm	○	○	○	○	○	○	○
1.8 Disorganised, careless	○	○	○	○	○	○	○
1.9 Calm, emotionally stable	○	○	○	○	○	○	○
1.10 Conventional, uncreative	○	○	○	○	○	○	○

Section Two: Social Support

The next group of questions are about your relationships with people.

	OFTEN	SOMETIMES	RARELY	NEVER
2.1 How often do friends make you feel cared for?	○	○	○	○
2.2 How often do they express interest in how you are doing?	○	○	○	○
2.3 How often do friends make too many demands on you?	○	○	○	○
2.4 How often do they criticise you?	○	○	○	○
2.5 How often do friends create tensions or arguments with you?	○	○	○	○
	OFTEN	**SOMETIMES**	**RARELY**	**NEVER**
2.6 How often do family make you feel cared for?	○	○	○	○
2.7 How often do family express interest in how you are doing?	○	○	○	○
2.8 How often do they make too many demands on you?	○	○	○	○
2.9 How often do family criticise you?	○	○	○	○
2.10 How often do they create tensions or arguments with you?	○	○	○	○

Section Three and Four: Negative Life Events

For each of these next questions, shade the circle that best describes your response.

3. Overall, I had a happy childhood.

○ Strongly disagree ○ Disagree ○ Neither agree nor disagree ○ Agree ○ Strongly agree

4. I have needed professional help to deal with emotional problems in the past.

○ Not at all ○ To a small extent ○ To a moderate extent ○ To a large extent ○ Totally

Section Five: Symptom Interpretation

Listed below are conditions you may or may not have ever experienced. For each condition, please shade the circle next to each reason or group of reasons that corresponds to how much that might explain your condition. Please check every item for each question. Also, answer whether you have had the condition in the last 3 months by shading the 'Yes' or 'No' circle as appropriate.

	NOT AT ALL	SOME-WHAT	QUITE A BIT	A GREAT DEAL
5.1 If I had a prolonged headache, I would probably think that it is because:				
I am emotionally upset	○	○	○	○
There is something wrong with my muscles, nerves or brain	○	○	○	○
A loud noise, bright light or something else has irritated me	○	○	○	○
Have you had a prolonged headache in the last 3 months?		○ Yes	○ No	

	NOT AT ALL	SOME-WHAT	QUITE A BIT	A GREAT DEAL
5.2. If I was sweating a lot, I would probably think that it is because:				
I must have a fever or infection	○	○	○	○
I'm anxious or nervous	○	○	○	○
The room is too warm, I'm overdressed or working too hard	○	○	○	○
Have you noticed yourself sweating a lot in the last 3 months?		○ Yes	○ No	

	NOT AT ALL	SOME-WHAT	QUITE A BIT	A GREAT DEAL
5.3 If I got dizzy all of a sudden, I would probably think it is because:				
There is something wrong with my heart or blood pressure	○	○	○	○
I am not eating enough or I got up too quickly	○	○	○	○
I must be under alot of stress	○	○	○	○
Have you felt dizzy in the last 3 months?		○ Yes	○ No	

	NOT AT ALL	SOME-WHAT	QUITE A BIT	A GREAT DEAL
5.4 If I noticed my mouth was dry, I would probably think that is because:				
I must be scared or anxious about something	○	○	○	○
I need to drink more liquids	○	○	○	○
There is something wrong with my salivary glands	○	○	○	○
Have you had a dry mouth in the last 3 months?		○ Yes	○ No	

Section Five: Symptom Interpretation

	NOT AT ALL	SOME-WHAT	QUITE A BIT	A GREAT DEAL
5.5 If I felt my heart pounding in my chest, I would probably think that this is because:				
I've exerted myself or drunk a lot of coffee	○	○	○	○
I must be really excited or afraid	○	○	○	○
There must be something wrong with my heart	○	○	○	○
Have you noticed your heart pounding in the last 3 months?		○ Yes	○ No	

	NOT AT ALL	SOME-WHAT	QUITE A BIT	A GREAT DEAL
5.6 If I felt fatigued, I would probably think that it is because:				
I'm emotionally exhausted or discouraged	○	○	○	○
I've been over exerting myself or not exercising enough	○	○	○	○
I'm anaemic or my blood is weak	○	○	○	○
Have you felt fatigued in the last 3 months?		○ Yes	○ No	

	NOT AT ALL	SOME-WHAT	QUITE A BIT	A GREAT DEAL
5.7 If I noticed my hand trembling, I would probably think that it is because:				
I might have some sort of neurological problem	○	○	○	○
I'm very nervous	○	○	○	○
I've tired the muscle in my hand	○	○	○	○
Have you noticed your hands trembling in the last 3 months?		○ Yes	○ No	

	NOT AT ALL	SOME-WHAT	QUITE A BIT	A GREAT DEAL
5.8 If I had trouble sleeping, I would probably think that it is because:				
Some kind of pain or physical discomfort is keeping me awake	○	○	○	○
I'm not tired or I had too much coffee	○	○	○	○
I'm worrying too much or I must be nervous about something	○	○	○	○
Have you had trouble sleeping in the last 3 months?		○ Yes	○ No	

Section Five: Symptom Interpretation

	NOT AT ALL	SOME-WHAT	QUITE A BIT	A GREAT DEAL
5.9 If my stomach was upset, I would probably think that it is because:				
I've worried myself sick	○	○	○	○
I have the flu or stomach irritation	○	○	○	○
I've had something to eat that did not agree with me	○	○	○	○
Have you had an upset stomach in the last 3 months?		○ Yes	○ No	

	NOT AT ALL	SOME-WHAT	QUITE A BIT	A GREAT DEAL
5.10 If I lost my appetite, I would probably think that it is because:				
I've been eating too much or my body doesn't need as much food as before	○	○	○	○
I'm worrying so much that food just doesn't taste good anymore	○	○	○	○
I have some stomach or intestinal problem	○	○	○	○
Have you lost your appetite in the last 3 months?		○ Yes	○ No	

	NOT AT ALL	SOME-WHAT	QUITE A BIT	A GREAT DEAL
5.11 If I had a hard time catching my breath, I would probably think that it is because:				
My lungs are congested from infection, irritation or heart trouble	○	○	○	○
The room is stuffy or there is too much pollution in the air	○	○	○	○
I'm over excited or anxious	○	○	○	○
Have you had a hard time catching your breath in the last 3 months?		○ Yes	○ No	

	NOT AT ALL	SOME-WHAT	QUITE A BIT	A GREAT DEAL
5.12 If I noticed numbness or tingling in my hands or feet, I would probably think that it is because:				
I'm under emotional stress	○	○	○	○
There is something wrong with my nerves or blood circulation	○	○	○	○
I am cold or my hand or foot went to sleep	○	○	○	○
Have you had numbness or tingling in your hands or feet in the last 3 months?		○ Yes	○ No	

Section Five: Symptom Interpretation

	NOT AT ALL	SOME-WHAT	QUITE A BIT	A GREAT DEAL
5.13 If I was constipated or irregular, I would probably think that it is because:				
There is not enough fruit or fibre in my diet	○	○	○	○
Nervous tension is keeping me from being regular	○	○	○	○
There is something wrong with my bowels or intestine	○	○	○	○
Have you been constipated in the last 3 months?		○ Yes	○ No	

Section Six: Pre-existing Traumatic Exposures

Please indicate if you have ever in your lifetime experienced any of the following events:

	EXPERIENCED EVENT	NO. OF TIMES	AGE FIRST TIME	AGE LAST TIME
6.1 Direct combat	○ No ○ Yes			
6.2 Life-threatening accident	○ No ○ Yes			
6.3 Fire, flood, or other natural disaster	○ No ○ Yes			
6.4 Witness someone badly injured or killed	○ No ○ Yes			
6.5 Rape	○ No ○ Yes			
6.6 Sexual molestation	○ No ○ Yes			
6.7 Serious physical attack or assault	○ No ○ Yes			
6.8 Threatened / harassed without weapon	○ No ○ Yes			
6.9 Threatened with weapon / held captive / kidnapped	○ No ○ Yes			
6.10 Tortured or victim of terrorists	○ No ○ Yes			
6.11 Domestic violence	○ No ○ Yes			
6.12 Witnessed domestic violence	○ No ○ Yes			
6.13 Finding dead body	○ No ○ Yes			
6.14 Witnessed someone suicide or attempt suicide	○ No ○ Yes			
6.15 Child abuse - physical	○ No ○ Yes			
6.16 Child abuse - emotional	○ No ○ Yes			
6.17 Any other stressful event, please specify:	○ No ○ Yes			
6.18 Did you ever suffer a great shock because one of these events happened to someone close to you? Please specify event type.	○ No ○ Yes			

Section Seven: Alexithymia

Using the scale provided as a guide, indicate how much you agree or disagree with each of the following statements by shading the corresponding circle. Give only one answer for each statement.

	STRONGLY DISAGREE	MODERATELY DISAGREE	NEITHER DISAGREE NOR AGREE	MODERATELY AGREE	STRONGLY AGREE
7.1 I am often confused about what emotion I am feeling.	○	○	○	○	○
7.2 It is difficult for me to find the right words for my feelings.	○	○	○	○	○
7.3 I have physical sensations that even doctors don't understand.	○	○	○	○	○
7.4 I am able to describe my feelings easily.	○	○	○	○	○
7.5 I prefer to analyse problems rather than just describe them.	○	○	○	○	○
7.6 When I am upset, I don't know if I am sad, frightened, or angry.	○	○	○	○	○
7.7 I am often puzzled by sensations in my body.	○	○	○	○	○
7.8 I prefer to just let things happen rather than to understand why they turned out that way.	○	○	○	○	○
7.9 I have feelings that I can't quite identify.	○	○	○	○	○
7.10 Being in touch with emotions is essential.	○	○	○	○	○
7.11 I find it hard to describe how I feel about people.	○	○	○	○	○
7.12 People tell me to describe my feelings more.	○	○	○	○	○
7.13 I don't know what's going on inside me.	○	○	○	○	○
7.14 I often don't know why I am angry.	○	○	○	○	○
7.15 I prefer talking to people about their daily activities rather than their feelings.	○	○	○	○	○
7.16 I prefer to watch "light" entertainment shows rather than psychological dramas.	○	○	○	○	○
7.17 It is difficult for me to reveal my innermost feelings, even to close friends.	○	○	○	○	○
7.18 I can feel close to someone, even in moments of silence.	○	○	○	○	○
7.19 I find examination of my feelings useful in solving personal problems.	○	○	○	○	○
7.20 Looking for hidden meanings in movies or plays distracts from their enjoyment.	○	○	○	○	○

Appendix 2

Middle East Area of Operations (MEAO) Prospective Health Study Post-Deployment Questionnaire

CMVH
CENTRE FOR MILITARY & VETERANS' HEALTH

MilHOP
Military Health Outcomes Program

Middle East Area of Operations (MEAO) Prospective Health Study Post Deployment Questionnaire

Part 1: Post Deployment Health Questionnaire

Part 2: Deployment Experiences Questionnaire

For the purposes of this study, deployment to the Middle East Area of Operations includes:

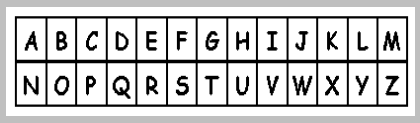
- Deployment to Iraq or areas supporting operations in Iraq;
- Deployment to Afghanistan or areas supporting operations in Afghanistan.

For more information please refer to the instructions on the following page. If you are still uncertain regarding your eligibility to participate in this study, please contact the study team on 1800 232 904 or email cmvh@adelaide.org.au

Instructions to complete this questionnaire:

This questionnaire asks about your physical and mental health. All information you provide in this questionnaire will be de-identified and will not be linked to other data we have collected about your health without your consent.

Please complete all sections by following the instructions at the beginning of each question. Please **shade circles**, rather than ticking or crossing them, and write clearly and in **capital letters**.



If you make a mistake and wish to change your answer, simply cross out your mistake and choose the answer that is right for you.

Please use **blue or black pen**, not pencil.

Some questions may seem repetitive, but this is necessary due to the questions being grouped into scales.

If you have any questions, please call us on 1800 232 904.

SUPPORT

If you require support in regards to anything in this questionnaire, please refer to the contacts provided below:

ALL HOURS SUPPORT LINE (a confidential telephone triage support service for ADF members and their families)
1800 628 036; outside Australia +61 2 9425 3878

LIFELINE
13 11 14

VETERANS AND VETERANS' FAMILY COUNSELLING SERVICE
1800 011 046

VETERANS' AFFAIRS NETWORK (VAN)
1300 551 918; non-metro 1800 555 254

DEPARTMENT OF VETERANS' AFFAIRS
13 32 54

NATIONAL OFFICE FOR THE MILITARY COMPENSATION AND REHABILITATION SERVICE
1300 550 461

For questions, problems or concerns, or to have your name removed from the mailing list please contact:

THE STUDY TEAM: The Centre for Military and Veterans' Health
Freecall 1800 232 904; cmvh@adelaide.edu.au

FIRST CHIEF INVESTIGATOR: Professor Annette Dobson, University of Queensland
(07) 3365 5346; a.dobson@uq.edu.au

If you prefer to speak to an independent officer of the Universities or Defence Force not involved in the study, you may contact an ethics officer on the numbers listed below:

THE AUSTRALIAN DEFENCE HUMAN RESEARCH ETHICS COMMITTEE
Executive Secretary: (02) 6266 3837; ADHREC@defence.gov.au

THE UNIVERSITY OF ADELAIDE RESEARCH BRANCH
Secretary, Human Research Ethics Committee: (08) 8303 6028

THE DEPARTMENT OF VETERANS' AFFAIRS HUMAN RESEARCH ETHICS COMMITTEE
HREC Coordinator: (02) 6289 6204; ethics.committee@dva.gov.au

Part 1:
Post-deployment Health Questionnaire

Section One: Background Details

1.1 What is today's date? (dd/mm/yyyy) ☐☐ / ☐☐ / ☐☐☐☐

1.2 Are you male or female? ○ Male ○ Female

1.3 What is your date of birth? (dd/mm/yyyy) ☐☐ / ☐☐ / ☐☐☐☐

1.4 Are you currently in a significant intimate relationship?

○ Yes - go to question 1.4a
○ No - go to question 1.4b

1.4a Are you:

○ Married and living together
○ Married with unaccompanied spouse (i.e. married partner currently lives elsewhere)
○ Living with partner (ADF recognised)
○ Living with partner (not ADF recognised)
○ In a long term relationship but not living together

1.4b Are you:

○ Never married - go to question 1.8
○ Previously married but now divorced - go to question 1.8
○ Previously married but now separated - go to question 1.8
○ Other, please specify: - go to question 1.8

1.5 Were you in a significant intimate relationship before the beginning of your last deployment to the MEAO?

○ Yes - go to question 1.5a
○ No - go to question 1.5b

1.5a Were you:

○ Married and living together
○ Married with unaccompanied spouse (i.e. married partner currently lives elsewhere)
○ Living with partner (ADF recognised)
○ Living with partner (not ADF recognised)
○ In a long term relationship but not living together

1.5b Were you:

○ Never married - go to question 1.8
○ Previously married but now divorced - go to question 1.8
○ Previously married but now separated - go to question 1.8
○ Other, please specify: - go to question 1.8

1.6 How satisfied are you with your current marriage / relationship?

○ Extremely satisfied
○ Satisfied
○ Neither satisfied or dissatisfied
○ Dissatisfied
○ Extremely dissatisfied
○ Not applicable

1.7 Have you or your spouse / partner seriously suggested the idea of divorce or permanent separation since the beginning of your last deployment to the MEAO? ○ Yes ○ No ○ Not applicable

Section One: Background Details

1.8 Overall, what impact have your military commitments (now, or in the past if you have left the military) had on your:

a) Marriage / relationship?
- ○ No impact
- ○ Positive impact
- ○ Negative impact
- ○ Not applicable

b) Children?
- ○ No impact
- ○ Positive impact
- ○ Negative impact
- ○ Not applicable

1.9 Which category best describes the highest educational qualification you have completed? Choose one.
- ○ Primary school
- ○ Secondary school up to grade 10
- ○ Secondary school grades 11-12
- ○ Certificate (trade, apprenticeship, technicians etc)
- ○ Diploma (associate, undergraduate)
- ○ Bachelor degree
- ○ Post-graduate qualification

1.10 How many hours per week do you usually work, when you are not on deployment? | | | | hours

1.11 To the nearest year, how long have you served with the Australian Defence Force: (if more than 0, but less than 1 year, please enter 1)

a) As a regular? | | | years *or* ○ Not applicable

b) As a reservist? | | | years *or* ○ Not applicable

1.12 What is your CURRENT rank or what WAS your rank when you left the military?
- ○ Senior Commissioned Officer (CMDR / LTCOL / WGCDR and above)
- ○ Commissioned Officer (LCDR / MAJ / SQNLDR and below)
- ○ Senior Non-Commissioned Officer (PO / SGT and above)
- ○ Junior Non-Commissioned Officer (LS / CPL and below)
- ○ Other ranks (AB / SMN / PTE / LAC / AC or equivalent)

1.13 In the past THREE YEARS, roughly how many months in total have you been away on Operational deployment? (if more than 0, but less than 1 month, please enter 1) | | months

If you are still a member of the regular Australian Defence Force, please go to Section Two.

If you are a Reservist or have discharged from the regular Australian Defence Force, please complete the following questions.

Section One: Background Details

1.14 What year did you discharge from the Regular Australian Defence Force?

or

○ Not applicable, I am a Reservist

1.15 Did you discharge to the Reserves or out of the ADF completely? ○ Reserves ○ Out of ADF ○ Not applicable, I have always been a reservist

1.16 What is your current employment status?

○ Paid employment full-time
○ Paid employment part-time / casual
○ Volunteer / community work
○ Student
○ Home Duties
○ Retired
○ Not working due to ill-health / TPI
○ Unemployed
○ Other, please specify:

1.17 Since you separated from the ADF, have you had a period of unemployment greater than 3 months? ○ Yes ○ No ○ Not applicable

If YES, was this period of unemployment primarily due to health problems? ○ Yes ○ No

If YES, please specify type:

1.18 What is your main source of income now? Choose one.

○ Wage or salary
○ Own business or share in a partnership
○ Age Service pension
○ Invalidity Service Pension
○ Compensation benefit under the VEA
○ Compensation benefit under the SRCA
○ Compensation benefit under the MRCA
○ Other government pension / allowance / benefit
○ Child allowance
○ Superannuation / annuity
○ Dividends / interest / income from investments
○ Other, please specify:

Section Two: Recent Health Symptoms

We would like to know about your health in the past month. Please indicate whether or not you have suffered any of the following symptoms in the past month, and if so, please indicate whether your symptoms were mild, moderate or severe in nature.

In the past month have you suffered from:	NO	YES		
2.1 Chest pain	○ No	○ Mild	○ Moderate	○ Severe
2.2 Headaches	○ No	○ Mild	○ Moderate	○ Severe
2.3 Rapid heartbeat	○ No	○ Mild	○ Moderate	○ Severe
2.4 Irritability / outbursts of anger	○ No	○ Mild	○ Moderate	○ Severe
2.5. Unable to breathe deeply enough	○ No	○ Mild	○ Moderate	○ Severe
2.6 Faster breathing than normal	○ No	○ Mild	○ Moderate	○ Severe
2.7 Feeling short of breath at rest	○ No	○ Mild	○ Moderate	○ Severe
2.8 Wheezing	○ No	○ Mild	○ Moderate	○ Severe
2.9 Sleeping difficulties	○ No	○ Mild	○ Moderate	○ Severe
2.10 Feeling jumpy / easily startled	○ No	○ Mild	○ Moderate	○ Severe
2.11 Feeling unrefreshed after sleep	○ No	○ Mild	○ Moderate	○ Severe
2.12 Fatigue	○ No	○ Mild	○ Moderate	○ Severe
2.13 Double vision	○ No	○ Mild	○ Moderate	○ Severe
2.14 Intolerance to alcohol	○ No	○ Mild	○ Moderate	○ Severe
2.15 Itchy or painful eyes	○ No	○ Mild	○ Moderate	○ Severe
2.16 Rash or skin irritation	○ No	○ Mild	○ Moderate	○ Severe
2.17 Skin infections e.g. boils	○ No	○ Mild	○ Moderate	○ Severe
2.18 Skin ulcers	○ No	○ Mild	○ Moderate	○ Severe
2.19 Shaking	○ No	○ Mild	○ Moderate	○ Severe
2.20 Tingling in fingers and arms	○ No	○ Mild	○ Moderate	○ Severe
2.21 Tingling in legs and toes	○ No	○ Mild	○ Moderate	○ Severe
2.22 Numbness in fingers / toes	○ No	○ Mild	○ Moderate	○ Severe
2.23 Feeling distant or cut off from others	○ No	○ Mild	○ Moderate	○ Severe
2.24 Constipation	○ No	○ Mild	○ Moderate	○ Severe
2.25 Flatulence or burping	○ No	○ Mild	○ Moderate	○ Severe

Section Two: Recent Health Symptoms

In the past month have you suffered from:	NO	YES		
2.26 Stomach cramps	○ No	○ Mild	○ Moderate	○ Severe
2.27 Diarrhoea	○ No	○ Mild	○ Moderate	○ Severe
2.28 Indigestion	○ No	○ Mild	○ Moderate	○ Severe
2.29 Dry mouth	○ No	○ Mild	○ Moderate	○ Severe
2.30 Pain in the face, jaw, in front of the ear, or in the ear	○ No	○ Mild	○ Moderate	○ Severe
2.31 Persistent cough	○ No	○ Mild	○ Moderate	○ Severe
2.32 Lump in throat	○ No	○ Mild	○ Moderate	○ Severe
2.33 Sore throat	○ No	○ Mild	○ Moderate	○ Severe
2.34 Forgetfulness	○ No	○ Mild	○ Moderate	○ Severe
2.35 Dizziness, fainting or blackouts	○ No	○ Mild	○ Moderate	○ Severe
2.36 Seizures or convulsions	○ No	○ Mild	○ Moderate	○ Severe
2.37 Feeling disorientated	○ No	○ Mild	○ Moderate	○ Severe
2.38 Loss of concentration	○ No	○ Mild	○ Moderate	○ Severe
2.39 Difficulty finding the right word	○ No	○ Mild	○ Moderate	○ Severe
2.40 Pain on passing urine	○ No	○ Mild	○ Moderate	○ Severe
2.41 Passing urine more often	○ No	○ Mild	○ Moderate	○ Severe
2.42 Burning sensation in the sex organs	○ No	○ Mild	○ Moderate	○ Severe
2.43 Loss of interest in sex	○ No	○ Mild	○ Moderate	○ Severe
2.44 Problems with sexual functioning	○ No	○ Mild	○ Moderate	○ Severe
2.45 Increased sensitivity to noise	○ No	○ Mild	○ Moderate	○ Severe
2.46 Increased sensitivity to light	○ No	○ Mild	○ Moderate	○ Severe
2.47 Increased sensitivity to smells or odours	○ No	○ Mild	○ Moderate	○ Severe
2.48 Ringing in the ears	○ No	○ Mild	○ Moderate	○ Severe
2.49 Avoiding doing things or situations	○ No	○ Mild	○ Moderate	○ Severe
2.50 Pain, without swelling or redness, in several joints	○ No	○ Mild	○ Moderate	○ Severe
2.51 Joint stiffness	○ No	○ Mild	○ Moderate	○ Severe
2.52 Feeling that your bowel movement is not finished	○ No	○ Mild	○ Moderate	○ Severe

Section Two: Recent Health Symptoms

In the past month have you suffered from:	NO	YES		
2.53 Changeable bowel function (mixture of diarrhoea / constipation)	○ No	○ Mild	○ Moderate	○ Severe
2.54 General muscle aches or pains	○ No	○ Mild	○ Moderate	○ Severe
2.55 Loss of balance or coordination	○ No	○ Mild	○ Moderate	○ Severe
2.56 Difficulty speaking	○ No	○ Mild	○ Moderate	○ Severe
2.57 Low back pain	○ No	○ Mild	○ Moderate	○ Severe
2.58 Night sweats which soak the bed sheets	○ No	○ Mild	○ Moderate	○ Severe
2.59 Feeling feverish	○ No	○ Mild	○ Moderate	○ Severe
2.60 Tender or painful swelling of lymph glands in neck, armpit or groin	○ No	○ Mild	○ Moderate	○ Severe
2.61 Loss of, or decrease in, appetite	○ No	○ Mild	○ Moderate	○ Severe
2.62 Nausea	○ No	○ Mild	○ Moderate	○ Severe
2.63 Vomiting	○ No	○ Mild	○ Moderate	○ Severe
2.64 Distressing dreams	○ No	○ Mild	○ Moderate	○ Severe
2.65 Stomach bloating	○ No	○ Mild	○ Moderate	○ Severe
2.66 Unintended weight gain greater than 4kg	○ No	○ Mild	○ Moderate	○ Severe
2.67 Unintended weight loss greater than 4kg	○ No	○ Mild	○ Moderate	○ Severe

Section Two: Recent Health Symptoms

2.68 Since the beginning of your last deployment, have you experienced any of the following events?		
Blast or Explosion IED (improvised explosive device)	O No	O Yes
RPG (rocket propelled grenade), Land Mine, Grenade, etc.	O No	O Yes
Vehicular accident / crash (any vehicle, including aircraft)	O No	O Yes
Fragment wound or bullet wound above the shoulders	O No	O Yes
Fall	O No	O Yes

If NO to all events in 2.68: please skip to question 3.1. Otherwise, continue.

2.69 How many times in total have you experienced each of the following symptoms immediately after any of the events listed above?	
Loss of consciousness / "knocked out"	[ ][ ] times
Being dazed, confused, or "seeing stars"	[ ][ ] times
Not remembering the event	[ ][ ] times
Concussion	[ ][ ] times
Head injury	[ ][ ] times

2.70 Did any of the following problems begin or get worse after any of the events listed above?					
Memory problems or lapses	O No	O Yes	Irritability	O No	O Yes
Balance problems or dizziness	O No	O Yes	Headaches	O No	O Yes
Sensitivity to bright light	O No	O Yes	Sleep problems	O No	O Yes

2.71 In the past week, have you had any of these symptoms?					
Memory problems or lapses	O No	O Yes	Irritability	O No	O Yes
Balance problems or dizziness	O No	O Yes	Headaches	O No	O Yes
Sensitivity to bright light	O No	O Yes	Sleep problems	O No	O Yes

Section Three: Your Health Now

This next set of questions ask for your views about your health. This information will help you to keep track of how you feel and how well you are able to do your usual activities.

For each of the following questions, please shade the circle that best describes your answer.

3.1 In general, how would you say your health is? ○ Excellent ○ Very good ○ Good ○ Fair ○ Poor

3.2 The following questions are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?

Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf?	○ Yes, limited a lot	○ Yes, limited a little	○ No, not limited at all
Climbing several flights of stairs?	○ Yes, limited a lot	○ Yes, limited a little	○ No, not limited at all

3.3 During the past 4 weeks, how much of the time have you had any of the following problems with your work or other regular daily activities as a result of your physical health?

	ALL OF THE TIME	MOST OF THE TIME	SOME OF THE TIME	A LITTLE OF THE TIME	NONE OF THE TIME
Accomplished less than you would like	○	○	○	○	○
Were limited in the kind of work or other activities	○	○	○	○	○

3.4 During the past 4 weeks, how much of the time have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)?

	ALL OF THE TIME	MOST OF THE TIME	SOME OF THE TIME	A LITTLE OF THE TIME	NONE OF THE TIME
Accomplished less than you would like	○	○	○	○	○
Did work or other activities less carefully than usual	○	○	○	○	○

3.5 During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and housework)?

○ Not at all ○ A little bit ○ Moderately ○ Quite a bit ○ Extremely

3.6 These questions are about how you feel and how things have been with you during the past 4 weeks. For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the past 4 weeks...

	ALL OF THE TIME	MOST OF THE TIME	SOME OF THE TIME	A LITTLE OF THE TIME	NONE OF THE TIME
Have you felt calm and peaceful?	○	○	○	○	○
Did you have a lot of energy?	○	○	○	○	○
Have you felt downhearted and depressed?	○	○	○	○	○

3.7 During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting friends, relatives etc.)?

○ All of the time ○ Most of the time ○ Some of the time ○ A little of the time ○ None of the time

Section Three: Your Health Now

In general, how would you rate your:	EXCELL-ENT	VERY GOOD	GOOD	FAIR	POOR
3.8 Overall health?	○	○	○	○	○
3.9 Quality of life?	○	○	○	○	○
3.10 Eyesight (with glasses or contact lenses, if you wear them)?	○	○	○	○	○
3.11 Hearing?	○	○	○	○	○
3.12 Memory?	○	○	○	○	○
3.13 Teeth and gums?	○	○	○	○	○

The following questions inquire about how you have been feeling over the last four (4) weeks. Please read each question carefully and then indicate, by shading the circle, the response that best describes how you have been feeling.	ALL OF THE TIME	MOST OF THE TIME	SOME OF THE TIME	A LITTLE OF THE TIME	NONE OF THE TIME
3.14 In the past four (4) weeks, about how often did you feel tired for no good reason?	○	○	○	○	○
3.15 In the past four (4) weeks, about how often did you feel nervous?	○	○	○	○	○
3.16 In the past four (4) weeks, about how often did you feel so nervous that nothing could calm you down?	○	○	○	○	○
3.17 In the past four (4) weeks, about how often did you feel hopeless?	○	○	○	○	○
3.18 In the past four (4) weeks, about how often did you feel restless or fidgety?	○	○	○	○	○
3.19 In the past four (4) weeks, about how often did you feel so restless that you could not sit still?	○	○	○	○	○
3.20 In the past four (4) weeks, about how often did you feel depressed?	○	○	○	○	○
3.21 In the past four (4) weeks, about how often did you feel that everything was an effort?	○	○	○	○	○
3.22 In the past four (4) weeks, about how often did you feel so sad that nothing could cheer you up?	○	○	○	○	○
3.23 In the past four (4) weeks, about how often did you feel worthless?	○	○	○	○	○

Section Three: Your Health Now

The next few questions are about how these feelings may have affected you in the past four (4) weeks. You need not answer these questions if you answered 'None of the time' to all of the previous ten questions about your feelings.

3.24 In the past four (4) weeks, how many days were you TOTALLY UNABLE to work, study or manage your day to day activities because of these feelings? | | | days

3.25 [Aside from those days], in the past four (4) weeks, HOW MANY DAYS were you able to work or study or manage your day to day activities, but had to CUT DOWN on what you did because of these feelings? | | | days

3.26 In the past four (4) weeks, how many times have you seen a doctor or any other health professional about these feelings? | | | times

3.27 In the past four (4) weeks, how often have physical health problems been the main cause of these feelings?

○ None of the time ○ A little of the time ○ Some of the time ○ Most of the time ○ All of the time

3.28 Please rate the following statements based on how you have felt in the <u>past 30 days</u> using the scale below.

	NOT TRUE AT ALL	RARELY TRUE	SOME-TIMES TRUE	OFTEN TRUE	TRUE NEARLY ALL THE TIME
a) I am able to adapt to change	○	○	○	○	○
b) I tend to bounce back after illness or hardship	○	○	○	○	○

Section Three: Your Health Now

Since returning from your last MEAO deployment, has a medical doctor diagnosed you with, or treated you for any of the following medical problems or conditions?

	YES	NO
3.29 High blood pressure	○	○
3.30 Migraines	○	○
3.31 Bowel disorder e.g. diarrhoea, constipation, bleeding	○	○
3.32 Eye or vision problems e.g. glaucoma	○	○
3.33 Hearing loss	○	○
3.34 Malaria	○	○
3.35 Any other significant infections, please specify type:	○	○
3.36 Arthritis or rheumatism	○	○
3.37 Back or neck problems	○	○
3.38 Joint problems	○	○
3.39 Asthma	○	○
3.40 Bronchitis	○	○
3.41 Sinus problems	○	○
3.42 Hay fever	○	○
3.43 Ear infection	○	○
3.44 Dermatitis	○	○
3.45 Any other skin problem, please specify type:	○	○
3.46 Skin cancer e.g. squamous cell or basal cell skin cancers	○	○
3.47 Any other kind of cancer, tumour or malignancy, please specify type:	○	○
3.48 Anxiety, stress or depression	○	○
3.49 Post traumatic stress disorder	○	○

Section Three: Your Health Now

	YES	NO
3.50 Other psychiatric or psychological condition needing treatment or counselling, please specify type:	○	○
3.51 Any other medical condition, please specify type:	○	○

Section Four: Lifestyle Behaviours

4.1 Since the beginning of your last deployment to the MEAO, have you used any of the following tobacco products?

	NO	YES
a. Cigarettes	○	○
b. Cigars	○	○
c. Pipes	○	○
d. Smokeless tobacco (e.g. chew, dip, snuff)	○	○

4.2 In your lifetime, have you smoked at least 100 cigarettes (5 packs)?

○ No - **please skip to question 4.9**

○ Yes - **continue to next question**

4.3 At what age did you start smoking? ☐☐ years old

4.4 How many years have you, or did you, smoke an average of at least 3 cigarettes per day (or one pack per week)? ☐☐ years

4.5 When smoking, how many packs (25 cigarettes) per day did you, or do you, smoke?

○ Less than half a pack per day
○ Half to 1 pack per day
○ 1 to 2 packs per day
○ More than 2 packs per day

4.6 Have you ever tried to quit smoking?

○ Yes, and succeeded
○ Yes, but not successfully
○ No

4.7 Was your smoking pattern different while on your last deployment to the MEAO?

○ I did not smoke on deployment
○ I smoked less than usual while on deployment
○ I smoked the same amount on deployment as when not deployed
○ I smoked more than usual while on deployment
○ I began / restarted smoking on deployment

4.8 If your smoking pattern changed during your deployment, what was the main reason?

Section Four: Lifestyle Behaviours

4.9. How often do you have a drink containing alcohol?	Never	Monthly or Less	2 to 4 times a month	2 to 3 times a week	4 or more times a week
	○	○	○	○	○

In answering the following questions, please remember that a standard drink contains 10g of pure alcohol

4.10 How many 'standard' drinks (see above) containing alcohol do you have on a typical day when you are drinking?	1 or 2	3 or 4	5 or 6	7 to 9	10 or more	N/A
	○	○	○	○	○	○

	NEVER	LESS THAN MONTHLY	MONTHLY	WEEKLY	DAILY OR ALMOST DAILY
4.11 How often do you have six or more drinks on one occasion?	○	○	○	○	○
4.12 How often since the beginning of your last deployment have you found that you were not able to stop drinking once you had started?	○	○	○	○	○
4.13 How often since the beginning of your last deployment have you failed to do what was normally expected from you because of drinking?	○	○	○	○	○

Section Four: Lifestyle Behaviours

	NEVER	LESS THAN ONCE A MONTH	MONTHLY	WEEKLY	DAILY OR ALMOST DAILY
4.14 How often since the beginning of your last deployment have you needed a drink in the morning to get yourself going after a heavy drinking session?	○	○	○	○	○
4.15 How often since the beginning of your last deployment have you had a feeling of guilt or remorse after drinking?	○	○	○	○	○
4.16 How often since the beginning of your last deployment have you been unable to remember what happened the night before because you had been drinking?	○	○	○	○	○

4.17 Have you or someone else been injured as a result of your drinking?	No ○	Yes, but not since the beginning of my last deployment ○	Yes, since the beginning of my last deployment ○
4.18 Has a relative, a friend, a doctor or other health professional been concerned about your drinking or suggested you cut down?	No ○	Yes, but not since the beginning of my last deployment ○	Yes, since the beginning of my last deployment ○

4.19 Do you presently have a problem with drinking?	No ○	Probably not ○	Unsure ○	Possibly ○	Definitely ○

4.20 In the next 3 months, how difficult would you find it to cut down or stop drinking?	Very easy ○	Fairly easy ○	Neither difficult nor easy ○	Fairly difficult ○	Very difficult ○	N/A ○

4.21 On an average day, how many 250 - 375ml beverages containing caffeine do you drink (such as caffeine containing energy drinks, coffee, tea, coca-cola)?

○ None ○ 1-2 per day ○ 3-5 per day ○ 6-10 per day ○ 11 or more per day

Section Four: Lifestyle Behaviours

4.22 Do you currently take any of the following supplements?

a) Body building supplements (such as amino acids, weight gain products, creatine, etc.)

○ Never ○ Less than once a month ○ Monthly ○ Weekly ○ Daily or almost daily

If YES, what was the name (generic or brand name) of the supplement(s) that you used?

b) Energy supplements (such as energy drinks, pills, or energy enhancing herbs)

○ Never ○ Less than once a month ○ Monthly ○ Weekly ○ Daily or almost daily

If YES, what was the name (generic or brand name) of the supplement(s) that you used?

c) Weight loss supplements

○ Never ○ Less than once a month ○ Monthly ○ Weekly ○ Daily or almost daily

If YES, what was the name (generic or brand name) of the supplement(s) that you used?

Since the beginning of your last deployment...

	NEVER	SOMETIMES	MOST OF THE TIME	ALMOST ALWAYS
4.23 Have you bet more than you could really afford to lose?	○	○	○	○
4.24 Have you needed to gamble with larger amounts of money to get the same feeling of excitement?	○	○	○	○
4.25 When you gambled, did you go back another day to try to win back the money you lost?	○	○	○	○
4.26 Have you borrowed money or sold anything to get money to gamble?	○	○	○	○
4.27 Have you felt that you might have a problem with gambling?	○	○	○	○
4.28 Has gambling caused you any health problems, including stress or anxiety?	○	○	○	○
4.29 Have people criticized your betting or told you that you had a gambling problem, regardless of whether or not you thought it was true?	○	○	○	○
4.30 Has your gambling caused any financial problems for you or your household?	○	○	○	○
4.31 Have you felt guilty about the way you gamble or what happens when you gamble?	○	○	○	○

Section Five: Life Experiences

Below is a list of problems and complaints that people sometimes have in response to stressful life experiences. Please read each one carefully, then shade the circle to the right to indicate how much you have been bothered by that problem in the past month.

	NOT AT ALL	A LITTLE BIT	MODERA-TELY	QUITE A BIT	EXTREM-ELY
5.1 Repeated, disturbing memories, thoughts or images of a stressful experience from the past?	○	○	○	○	○
5.2 Repeated, disturbing dreams of a stressful experience from the past?	○	○	○	○	○
5.3 Suddenly acting or feeling as if a stressful experience from the past were happening again (as if you were reliving it)?	○	○	○	○	○
5.4 Feeling very upset when something reminded you of a stressful experience from the past?	○	○	○	○	○
5.5 Having physical reactions (e.g. heart pounding, trouble breathing, sweating) when something reminded you of a stressful experience from the past?	○	○	○	○	○
5.6 Avoiding thinking about or talking about a stressful experience from the past or avoiding having feelings related to it?	○	○	○	○	○
5.7 Avoiding activities or situations because they reminded you of a stressful experience from the past?	○	○	○	○	○
5.8 Trouble remembering important parts of a stressful experience from the past?	○	○	○	○	○
5.9 Loss of interest in activities that you used to enjoy?	○	○	○	○	○
5.10 Feeling distant or cut off from other people?	○	○	○	○	○
5.11 Feeling emotionally numb or being unable to have loving feelings for those close to you?	○	○	○	○	○
5.12 Feeling as if your future somehow will be cut short?	○	○	○	○	○
5.13 Trouble falling or staying asleep?	○	○	○	○	○
5.14 Feeling irritable or having angry outbursts?	○	○	○	○	○
5.15 Having difficulty concentrating?	○	○	○	○	○
5.16 Being "superalert" or watchful or on guard?	○	○	○	○	○
5.17 Feeling jumpy or easily startled?	○	○	○	○	○

Section Five: Life Experiences

Below is a list of problems and complaints that people sometimes have in response to stressful life experiences. Please read each one carefully, then shade the circle to the right to indicate how much you have been bothered by that problem in the past month.

	NOT AT ALL	A LITTLE BIT	MODERA-TELY	QUITE A BIT	EXTREM-ELY
5.17a Having strong negative beliefs about yourself, other people, or the world (for example, having thoughts such as: I am bad, there is something seriously wrong with me, no one can be trusted, the world is completely dangerous)?	○	○	○	○	○
5.17b Blaming yourself or someone else severely for the stressful experience or what happened after it?	○	○	○	○	○
5.17c Having strong negative feelings such as fear, horror, anger, guilt, or shame?	○	○	○	○	○
5.17d Taking too many risks or doing things that cause you harm?	○	○	○	○	○

5.18 Thinking of the event(s) that you used to answer questions 5.1 - 5.17d, please list these events and the years they occurred below.

	Event description	Year
1		
2		
3		

5.19 Did any of these occur while on your deployment to the MEAO? ○ Yes ○ No

5.20 Did any of these occur during another overseas deployment? ○ Yes ○ No

5.21 Is there any other event that has caused you to have similar reactions?

○ No
○ Yes - while deployed
○ Yes - while NOT deployed

If yes, what was that event?

Year of event

Section Five: Life Experiences

5.22 Thinking over the past 4 weeks, shade the circle that best describes the amount of time you felt that way.

	NONE OF THE TIME	A LITTLE OF THE TIME	SOME OF THE TIME	MOST OF THE TIME	ALL OF THE TIME
a) I found myself getting angry at people or situations	○	○	○	○	○
b) When I got angry, I got really mad	○	○	○	○	○
c) When I got angry, I stayed angry	○	○	○	○	○
d) When I got angry at someone, I wanted to hit them	○	○	○	○	○
e) My anger interfered with my ability to get my work, study or other productive activity done	○	○	○	○	○
f) My anger prevented me from getting along with people as well as I'd have liked to	○	○	○	○	○
g) I became angry at myself when I did not perform as well or achieve what I wanted	○	○	○	○	○
h) I became angry at myself when I did not handle social situations as well as I wanted	○	○	○	○	○
i) My anger had a bad effect on my health	○	○	○	○	○

5.23 How often over the last month did you get into a fight with someone and hit the person?

○ Never ○ One time ○ Two times ○ Three or four times ○ Five or more times

5.24 How often over the last month did you threaten someone with physical violence?

○ Never ○ One time ○ Two times ○ Three or four times ○ Five or more times

Section Five: Life Experiences

Over the last 2 weeks, how often have you been bothered by any of the following problems?

	NOT AT ALL	SEVERAL DAYS	MORE THAN HALF THE DAYS	NEARLY EVERY DAY
5.25 Little interest or pleasure in doing things	○	○	○	○
5.26 Feeling down, depressed, or hopeless	○	○	○	○
5.27 Trouble falling or staying asleep, or sleeping too much	○	○	○	○
5.28 Feeling tired or having little energy	○	○	○	○
5.29 Poor appetite or overeating	○	○	○	○
5.30 Feeling bad about yourself, or that you are a failure, or have let yourself or your family down	○	○	○	○
5.31 Trouble concentrating on things, such as reading the newspaper or watching television	○	○	○	○
5.32 Moving or speaking so slowly that other people could have noticed? Or the opposite - being so fidgety or restless that you have been moving around a lot more than usual	○	○	○	○
5.33 Thoughts that you would be better off dead or of hurting yourself in some way	○	○	○	○

5.34 If you checked off any of these problems, how difficult have these problems made it for you to do your work, take care of things at home, or get along with other people?

○ Not difficult at all ○ Somewhat difficult ○ Very difficult ○ Extremely difficult

The next group of questions are about anxiety.

	NO	YES
5.35 In the last 4 weeks, have you had an anxiety attack - suddenly feeling fear or panic?	○	○
If NO: please skip to question 5.50		
5.36 Has this ever happened before?	○	○
5.37 Do some of these attacks come suddenly out of the blue - that is, in situations where you don't expect to be nervous or uncomfortable?	○	○
5.38 Do these attacks bother you a lot or are you worried about having another attack?	○	○

Section Five: Life Experiences

Think about your last bad anxiety attack.		
	NO	**YES**
5.39 Were you short of breath?	○	○
5.40 Did your heart race, pound, or skip?	○	○
5.41 Did you have chest pain or pressure?	○	○
5.42 Did you sweat?	○	○
5.43 Did you feel as if you were choking?	○	○
5.44 Did you have hot flushes or chills?	○	○
5.45 Did you have nausea or an upset stomach, or the feeling that you were going to have diarrhoea?	○	○
5.46 Did you feel dizzy, unsteady, or faint?	○	○
5.47 Did you have tingling or numbness in parts of your body?	○	○
5.48 Did you tremble or shake?	○	○
5.49 Were you afraid you were dying?	○	○

Over the last 4 weeks, how often have you been bothered by any of the following problems?			
	NOT AT ALL	**SEVERAL DAYS**	**MORE THAN HALF THE DAYS**
5.50 Feeling nervous, anxious, on edge, or worrying a lot about different things	○	○	○
If NOT AT ALL: please skip to question 5.57			
5.51 Feeling restless so that it is hard to sit still	○	○	○
5.52 Getting tired very easily	○	○	○
5.53 Muscle tension, aches, or soreness	○	○	○
5.54 Trouble falling asleep or staying asleep	○	○	○
5.55 Trouble concentrating on things, such as reading a book or watching TV	○	○	○
5.56 Becoming easily annoyed or irritable	○	○	○

Section Five: Life Experiences

Please shade the circles that best describe your experience.		
5.57 Since the beginning of your last deployment, have you ever felt that life was not worth living?	○ No	○ Yes
5.58 Since the beginning of your last deployment, have you ever felt so low that you thought about committing suicide?	○ No	○ Yes
5.59 Since the beginning of your last deployment, have you made a suicide plan?	○ No	○ Yes
5.60 Since the beginning of your last deployment, have you attempted suicide?	○ No	○ Yes

If you require support in relation to any issues you have identified in this survey, we encourage you to refer to the contacts provided on Page 3

5.61 Have you sought help for a stress, emotional, mental health or family problem in the last 12 months?	○ No	○ Yes

Using the scale provided, rate each of the possible reasons that might affect your decision to receive mental health counselling or services if you ever had a problem:

	STRONGLY DISAGREE	DISAGREE	NEUTRAL	AGREE	STRONGLY AGREE
5.62 It would be too embarrassing.	○	○	○	○	○
5.63 It would harm my career.	○	○	○	○	○
5.64 Members of my unit might have less confidence in me.	○	○	○	○	○
5.65 My unit leadership might treat me differently.	○	○	○	○	○
5.66 My leaders would blame me for the problem.	○	○	○	○	○
5.67 I would be seen as weak.	○	○	○	○	○
5.68 I don't trust mental health professionals.	○	○	○	○	○
5.69 I don't know where to get help.	○	○	○	○	○
5.70 I do not have confidence in military health, administrative, or social services.	○	○	○	○	○
5.71 It would stop me from being deployed again.	○	○	○	○	○
5.72 It is difficult to schedule an appointment.	○	○	○	○	○
5.73 There would be difficulty getting time off work for treatment.	○	○	○	○	○
5.74 I would want to deal with the problems on my own.	○	○	○	○	○

Section Six: Your Respiratory Health

The following questions ask you about any respiratory symptoms you may have experienced since the beginning of your last deployment.

	NO	YES
6.1 Have you had wheezing or whistling in your chest at any time since the beginning of your last deployment?	○	○
If YES:		
a. Have you been at all breathless when the wheezing noise was present?	○	○
b. Have you had this wheezing or whistling when you did not have a cold?	○	○
6.2 Have you woken up with a feeling of tightness in your chest at any time since the beginning of your last deployment?	○	○
6.3 Have you been woken by an attack of shortness of breath at any time since the beginning of your last deployment?	○	○
6.4 Have you been woken by an attack of coughing at any time since the beginning of your last deployment?	○	○
6.5 Have you had an attack of asthma since the beginning of your last deployment?	○	○
6.6 Are you currently taking any medicine for asthma (including inhalers, aerosols, or tablets)?	○	○
6.7 Do you have any nasal allergies including hay fever?	○	○

Section Seven: Recreation and Social Activities

Please answer the following questions regarding your recreation and social activities. How often do you…

	EVERY DAY	SEVERAL TIMES PER WEEK	WEEKLY OR FORT-NIGHTLY	MONTHLY	RARELY OR ON SPECIAL OCCASIONS	NEVER
7.1 Have contact with an ex-service organisation?	○	○	○	○	○	○
7.2 Have social contact with other veterans?	○	○	○	○	○	○
7.3 Have contact with friends or relatives?	○	○	○	○	○	○
7.4 Attend social activities such as watching sport, eating meals or watching movies?	○	○	○	○	○	○
7.5 Play sport (e.g. golf, fishing, exercise)?	○	○	○	○	○	○
7.6 Set aside time to do a hobby (e.g. wood work, craft, music)?	○	○	○	○	○	○
7.7 Set aside time to relax (e.g. watch TV, read, listen to music)?	○	○	○	○	○	○
7.8 Do voluntary work?	○	○	○	○	○	○

7.9 Do you commemorate significant military-related occasions such as attend ANZAC Day services, participate in marches or attend dawn services?	○ Yes	○ No
7.10 Do you know of other service veterans living near you?	○ Yes	○ No

Section Eight: Evaluation Questions

8.1 Are there other important health concerns we have not asked you about? ○ Yes ○ No

If **YES**: please give details in the space provided

8.2 Do you have any additional comments you would like to add? ○ Yes ○ No

If **YES**: please give details in the space provided

You are 2/3 of the way through. Keep going!

Part 2:
Deployment Questionnaire

Instructions to complete:

Please answer these questions in relation to your LAST deployment to the Middle East Area of Operations.

Section One: Deployment Details

1.1 On your MOST RECENT deployment to the MEAO, were you mainly based in: (please shade all that apply)

- O Tarin Kowt
- O Kandahar
- O Kabul
- O Other areas in Afghanistan
- O Other areas supporting Afghanistan
- O Iraq
- O Other areas supporting Iraq
- O Attachment to foreign militaries or UN

1.2 How many weeks lead time were you given prior to your last deployment to the MEAO? (if more than 0, but less than 1 week, please enter 1) ____ weeks

1.3 During your last deployment to the MEAO, what were your MAIN duties? (please shade all that apply)

- O Combat (e.g. Infantry, Artillery, etc.)
- O Medical (e.g. RMO, Environmental or Preventive Health, Nurses, Medics)
- O Security
- O EOD (Bomb Disposal, IED Technician)
- O Training Local Police / Army
- O Engineering
- O Logistics / Supply
- O Force Protection
- O Driver
- O Welfare (e.g. Chaplain, Psychologist)
- O Trades (e.g. Fitter, Mechanic)
- O Air Crew - Rotary Wing
- O Air Crew - Fixed Wing
- O Flight Operations Cell
- O Oil Platform Protection
- O Maritime Operations - Between Deck
- O Maritime Operations - Above Deck
- O Clearance Diver
- O Boarding Party
- O Administrative
- O Headquarters
- O CIMIC (Civil Military Co-operation)
- O Peacekeeping
- O Catering
- O Intelligence
- O Communications
- O Military Police
- O Other, please specify:

1.4 Were you required to work mixed duty cycles (ie. day - night - day shifts)? O Often O Sometimes O Rarely O Never

1.5 Were you permanently on night shifts during your last deployment to the MEAO? O Yes O No

1.6 About how many hours per day, on average, were you considered 'on duty'? ____ hours

1.7 How many days per month did you not work on your last deployment to the MEAO? (if more than 0, but less than 1 day, please enter 1) ____ days per month

Section One: Deployment Details

1.8 What was your rank during your last deployment to the MEAO?

- ○ Senior Commissioned Officer (CMDR / LTCOL / WGCDR and above)
- ○ Commissioned Officer (LCDR / MAJ / SQNLDR and below)
- ○ Senior Non-Commissioned Officer (PO / SGT and above)
- ○ Junior Non-Commissioned Officer (LS / CPL and below)
- ○ Other ranks (AB / SMN / PTE / LAC / AC or equivalent)

1.9 Please indicate your service status during your last deployment to the MEAO.

○ Reservist on full time service ○ Full time member ○ Other, please specify:

Section Two: Chemical and Environmental Exposures

During your last deployment to the MEAO, how often…?

	NEVER	ONCE	2-4 TIMES	5-9 TIMES	10+ TIMES
2.1 Were you exposed to smoke from fires / smoke from waste incineration / oil fire smoke?	○	○	○	○	○
2.2 Were you exposed to dust storms?	○	○	○	○	○
2.3 Were you exposed to an environment where you inhaled fine dust or fibres (e.g. driving vehicles, near operating aircraft, damaged building)?	○	○	○	○	○
2.4 Were you exposed to others' cigarette smoke in an enclosed recreational or work environment?	○	○	○	○	○
2.5 Were you exposed to diesel exhaust?	○	○	○	○	○
2.6 Were you exposed to aviation, marine or automotive fuels?	○	○	○	○	○
2.7 Were you exposed to aircraft fumes?	○	○	○	○	○
2.8 Were you exposed to toxic industrial chemicals?	○	○	○	○	○
2.9 Were you exposed to solvents (e.g. thinners, sealer, paints)?	○	○	○	○	○
2.10 Did you live in an area recently sprayed or fogged with chemicals?	○	○	○	○	○
2.11 Did you dip your cams to prevent insect bites?	○	○	○	○	○
2.12 Did you take medication to prevent or suppress malaria (e.g. Doxycycline, Primaquine)?	○	○	○	○	○
2.13 Were you close to loud noises and did not have hearing protection (e.g. explosions, weapon fire)?	○	○	○	○	○
2.14 Were you exposed to noise for extended periods of time without hearing protection (e.g. machinery, aircraft operations)?	○	○	○	○	○
2.15 Were you bitten by flies, sand flies, fleas, mosquitoes or other insects that required medical attention?	○	○	○	○	○
2.16 Did you have close contact with local animals (dogs, cats, rats, etc.)?	○	○	○	○	○
2.17 Did you come into contact with body fluids or blood?	○	○	○	○	○
2.18 Did you receive a blood transfusion?	○	○	○	○	○
2.19 Did you drink from local taps or wells?	○	○	○	○	○
2.20 Did you eat local food?	○	○	○	○	○
2.21 Did the food available have a negative effect on your performance?	○	○	○	○	○

Section Two: Chemical and Environmental Exposures

During your last deployment to the MEAO, how often…?

	NEVER	ONCE	2-4 TIMES	5-9 TIMES	10+
2.22 Did you swim or bath in local lakes, rivers or the sea?	○	○	○	○	○
2.23 Did you have contact with the local population?	○	○	○	○	○
2.24 Did you get sunburnt?	○	○	○	○	○
2.25 Were you close to sources of non-ionising radiation (e.g. radar or microwave, or EOD countermeasures)?	○	○	○	○	○
2.26 Did you have contact with any chemical or biological weapons?	○	○	○	○	○
2.27 Did you have contact with depleted uranium shell casings?	○	○	○	○	○
2.28 Did you enter or come in close proximity to recently destroyed vehicles?	○	○	○	○	○
2.29 Did you enter or come in close proximity to recently destroyed structures (e.g. buildings, bunkers, etc.)?	○	○	○	○	○
2.30 Were you exposed to ionising radiation or radioactive material?	○	○	○	○	○
2.31 Did you use an NBC suit (not for training purposes)?	○	○	○	○	○
2.32 Did you use a respirator (not for training purposes)?	○	○	○	○	○
2.33 Did you clear / search buildings?	○	○	○	○	○
2.34 Did you clear / search caves?	○	○	○	○	○
2.35 Did you come under small arms or anti-aircraft fire?	○	○	○	○	○
2.36 Did you come under guided or directed mortar / artillery fire or missile attack?	○	○	○	○	○
2.37 Did you experience in-direct fire (e.g. rocket attack)?	○	○	○	○	○
2.38 Did you seriously fear you would encounter an IED?	○	○	○	○	○
2.39 Did you experience an IED / EOD that detonated?	○	○	○	○	○
2.40 Did you experience a suicide bombing?	○	○	○	○	○
2.41 Did you experience a landmine strike?	○	○	○	○	○
2.42 Did you encounter small arms fire from an unknown enemy combatant (e.g. sniper, civilian with weapon)?	○	○	○	○	○
2.43 Did you discharge your weapon in direct combat?	○	○	○	○	○

Section Two: Chemical and Environmental Exposures

During your last deployment to the MEAO, how often…?	NEVER	ONCE	2-4 TIMES	5-9 TIMES	10+
2.44 Did you experience a threatening situation where you were unable to respond due to the rules of engagement?	○	○	○	○	○
2.45 Did you go on combat patrols or missions?	○	○	○	○	○
2.46 Did you participate in support convoys (eg. re-supply, VIP escort)?	○	○	○	○	○
2.47 Were you concerned about yourself or others (including allies) having an unauthorised discharge of a weapon?	○	○	○	○	○
2.48 Were you in danger of being killed? e.g. combat, motor vehicle accident (MVA), assault, hostage situation	○	○	○	○	○
2.49 Were you in danger of being injured? e.g. combat, MVA, assault, hostage situation	○	○	○	○	○
2.50 Did you handle dead bodies? e.g. combat, civilian casualties	○	○	○	○	○
2.51 Did you see dead bodies? e.g. combat, civilian casualties	○	○	○	○	○
2.52 Did you hear of a close friend or co-worker who had been injured or killed? e.g. combat, MVA, disaster situation	○	○	○	○	○
2.53 Were you present when a close friend or co-worker was injured or killed? e.g. combat, MVA, disaster situation	○	○	○	○	○
2.54 Did you fear that you had been exposed to a contagious disease, toxic agent or injury? e.g. radioactivity, HIV, chemical warfare	○	○	○	○	○
2.55 Were you witness to human degradation and misery on a large scale? e.g. refugee camps, starvation	○	○	○	○	○
2.56 Did you hear of a loved one who had been injured or killed?	○	○	○	○	○
2.57 Were you present when a loved one was injured or killed?	○	○	○	○	○
2.58 Do you believe your action or inaction resulted in someone being seriously injured? e.g. in combat or as a result of rules of engagement or UN restrictions not allowing you to act	○	○	○	○	○
2.59 Do you believe your actions or inaction resulted in someone being killed? e.g. in combat or as a result of rules of engagement or UN restrictions not allowing you to act	○	○	○	○	○

Section Two: Chemical and Environmental Exposures

2.60 During your last deployment to the MEAO, for how long were you outside your base in a hostile area in total?

- ○ Not at all
- ○ Up to one week
- ○ Up to one month
- ○ More than a month

2.61 Are there any additional experiences you would like to tell us about? Please comment.

Section Three: Your Work on Deployment

3.1 Did you feel that the work asked of you in theatre generally matched your trade experiences and ability?

- ○ Yes
- ○ No, work was generally above my trade experience and ability
- ○ No, work was generally beneath my trade experience and ability

3.2 Thinking of one very difficult experience on this deployment, do you feel that:

a) Your colleagues did what was expected of them?	○ Yes	○ No
b) You did what was expected of you?	○ Yes	○ No

The following statements relate to the equipment you were provided with while on your last deployment to the MEAO. Please indicate the degree to which you either agree or disagree with each statement.

	STRONGLY DISAGREE	SOMEWHAT DISAGREE	NEITHER AGREE NOR DISAGREE	SOMEWHAT AGREE	STRONGLY AGREE
3.3 I experienced pain or injury from using the equipment provided to me	○	○	○	○	○
3.4 I felt that I had adequate practical experience using my equipment	○	○	○	○	○
3.5 I had all the supplies and equipment needed to get my job done	○	○	○	○	○

3.6 If you agree with any of the above 3 questions, please give examples:

Section Three: Your Work on Deployment

3.7 The following questions ask about your work during your last deployment to the MEAO. Please answer how often you performed these duties during your deployment, and if you did perform the duty, whether you think this benefited the local community.

	NEVER	OCCAS-IONALLLY	FREQ-UENTLY	IF OCCASIONALLY OR FREQUENTLY, DO YOU THINK THIS BENEFITED THE LOCAL COMMUNITY?	
				YES	NO
a) Work with the National Police / Army (e.g. patrols)?	○	○	○	○	○
b) Assist in the building of infrastructure e.g. wells / roads?	○	○	○	○	○
c) Train local Police / Army?	○	○	○	○	○
d) Take part in Hearts and Minds campaigns, e.g. interacted with the community?	○	○	○	○	○
e) Work with DFAT* / NGO** or Aid organisations*** to assist the locals?	○	○	○	○	○

* DFAT = Department of Foreign Affairs and Trade
** NGO = Non-Government Organisation
*** Aid Organisation = e.g. Red Cross

3.8 How much do you agree or disagree with the following statements?

Please shade ONE circle for each statement under the answer that best describes how you felt during your deployment to the MEAO.

	STRONGLY AGREE	AGREE	NEITHER AGREE NOR DISAGREE	DISAGREE	STRONGLY DISAGREE
a) I felt a sense of comradeship (or closeness) between myself and other people in my Unit	○	○	○	○	○
b) There was someone I could go to in my Unit if I had a personal problem	○	○	○	○	○
c) My superiors were interested in what I did or thought	○	○	○	○	○
d) I felt well informed about what was going on in my Unit	○	○	○	○	○
e) I had good communication with other Australian forces / Australian H.Q. from my Unit	○	○	○	○	○

Section Four: Your Health on Deployment

4.1 How many times did you attend sick parade during your LAST deployment to the MEAO?			
If you did attend sick parade: What was the reason? (please shade all that apply)			
	YES	**NO**	**IF YES NUMBER OF DAYS OUT OF ROLE**
a) Injury from a motor vehicle accident	○	○	
b) Injury sustained in combat	○	○	
c) Musculoskeletal injury sustained in your job / role (not combat related)	○	○	
d) Musculoskeletal injury sustained during training	○	○	
e) Musculoskeletal injury sustained during recreation or sport	○	○	
f) Head injury / concussion	○	○	
If YES, how long were you unconscious?	days	hours	minutes
g) Heat stress / exhaustion / dehydration	○	○	
h) Effects of cold or exposure	○	○	
i) Respiratory illness (e.g. cold / flu)	○	○	
If YES, did you have a fever?	○	○	
j) Dental problems	○	○	
k) Skin rashes / irritations	○	○	
l) Diarrhoea and/or vomiting	○	○	
m) Other, please specify:	○	○	

Section Four: Your Health on Deployment

If you had diarrhoea or vomiting during your last deployment to the MEAO:

4.2 Did the symptoms of diarrhoea and/or vomiting prevent you from carrying out your duties? ○ Yes ○ No ○ Not Applicable, I did not have diarrhoea or vomiting

4.3 Did you need intravenous fluids (a drip) as a result of diarrhoea and/or vomiting? ○ Yes ○ No ○ Not Applicable, I did not have diarrhoea or vomiting

4.4 Did the symptoms of diarrhoea or vomiting resolve when you exited the MEAO? ○ Yes ○ No ○ Not Applicable, I did not have diarrhoea or vomiting

In regard to your sleep and rest while on your last deployment to the MEAO:

4.5 How well did you sleep? ○ Very poorly ○ Poorly ○ Neither good nor poorly ○ Good ○ Very good

4.6 How satisfied were you with your sleep?

○ Very dissatisfied ○ Dissatisfied ○ Neither satisfied nor dissatisfied ○ Satisfied ○ Very satisfied

4.7 Did you have difficulties with sleeping?

○ Not at all ○ A little ○ A moderate amount ○ Very much ○ An extreme amount

4.8 How much did any sleep problems worry you?

○ Not at all ○ A little ○ A moderate amount ○ Very much ○ An extreme amount

4.9 Did you take any medication to help you sleep? ○ No ○ Yes, once or twice ○ Yes, regularly

4.10 During your last deployment to the MEAO, on an average day, how many 250 - 375ml beverages containing caffeine did you drink (such as caffeine containing energy drinks, coffee, tea, coca-cola)?

○ None ○ 1-2 per day ○ 3-5 per day ○ 6-10 per day ○ 11 or more per day

Section Four: Your Health on Deployment

4.11 During your last deployment to the MEAO, did you take any of the following supplements?

a) Body building supplements (such as amino acids, weight gain products, creatine, etc.)

O Never O Less than once a month O Monthly O Weekly O Daily or almost daily

If YES, what was the name (generic or brand name) of the supplement that you used?

b) Energy supplements (such as energy drinks, pills, or energy enhancing herbs)

O Never O Less than once a month O Monthly O Weekly O Daily or almost daily

If YES, what was the name (generic or brand name) of the supplement that you used?

c) Weight loss supplements

O Never O Less than once a month O Monthly O Weekly O Daily or almost daily

If YES, what was the name (generic or brand name) of the supplement that you used?

4.12 Compared to your health BEFORE your last deployment to the MEAO, how would you rate your health in general NOW?

O Much better now O Somewhat better now O About the same O Somewhat worse now O Much worse now

4.13 To what extent do you agree with the following statement?

The change in my health is because of my last deployment to the MEAO.

O Strongly Agree O Agree O Neither Agree nor Disagree O Not applicable O Disagree O Strongly Disagree

Section Five: Other Deployment Experiences

5.1 During your last deployment to the MEAO, did you have any major personal problems at home? (e.g. financial problems, family problems, etc). Please shade ONE circle for each statement.

	AGREE	DISAGREE	NOT APPLICABLE
a) I received enough personal support from my family	○	○	○
b) I had serious financial problems	○	○	○
c) My partner / spouse left me	○	○	○
d) There were problems with my children	○	○	○
e) I was concerned I might lose my civilian job	○	○	○
f) I faced other major problems at home whilst deployed	○	○	○

5.2 Did the military provide any reassurance / support to your spouse / partner whilst you were deployed? (e.g. phone calls or visits, arranging 'get togethers' with other service families, newsletters, etc.)

- ○ Yes, it was sufficient
- ○ Yes, but it was not sufficient
- ○ No
- ○ Not applicable

Section Six: Post Deployment Experiences

6.1 Why did you exit from theatre? (Please shade ONE circle only)

- O End of Deployment
- O CASEVACed through combat related injury
- O CASEVACed through non-combat related injury
- O Compassionate leave
- O Problems at home
- O Routine change of role / appointment / posting
- O To attend professional courses
- O Other, please specify:

6.2 Did you receive a Return to Australia Psychological Screen brief? O Yes O No

If YES:

6.3 Do you believe this process was useful? (please shade ONE circle only)

O Not at all useful O Not particularly useful O Neither useful nor un-useful O Somewhat useful O Extremely useful

6.4 After leaving the theatre of operation, did you have a short period of time somewhere away from the operation area for you to relax before returning to your home base?

O Yes O No - **please skip to question 6.6**

6.5 **If YES:**

a) For how many days?

b) Was the majority of this time…?

- O Structured (a daily programme of activities, e.g. fitness)
- O Unstructured (no planned activities)

c) Did you find this period of time useful? O Yes O No

d) What were the good points?

e) What were the bad points?

Section Six: Post Deployment Experiences

6.6 After returning to your usual home base, were you required to spend some time in or around your home Unit before being allowed to go on Post Operational Leave?

- O Yes
- O No - **please skip to question 6.8**
- O Not applicable, did not go on Post Operational Leave - **please skip to question 6.8**

6.7 **If YES:**

a) For how many days were you required at your home Unit?

b) Was the majority of this time…?
- O Structured (a daily programme of activities e.g. fitness / administration)
- O Unstructured (no planned activities)

c) Did you find this period of time useful? O Yes O No

d) What were the good points?

e) What were the bad points?

6.8 How long was it before you could relax properly on return to Australia?

O Immediately O 1 Week O 2 Weeks O 3-4 Weeks O 4-8 Weeks O 9 or more weeks O Have not

6.9 How long before you stopped scanning the environment for risk?

O Immediately O 1 Week O 2 Weeks O 3-4 Weeks O 4-8 Weeks O 9 or more weeks O Have not

6.10 Overall, do you think the Australian public were supportive of the mission to the MEAO during your MOST RECENT deployment? O Yes O No

6.11 Since returning home from your last deployment, has anyone had a go at you, or given you a hard time because you went to the MEAO? O Yes O No

Section Six: Post Deployment Experiences

6.12 To what extent do you agree or disagree with the following statements?

In the weeks after I came home...

	AGREE	DISAGREE	NOT APPLICABLE
a) I was well supported by the military	○	○	
b) I found it difficult to adjust to being back home	○	○	
c) People didn't understand what I had been through	○	○	
d) I did not want to talk about my experiences with my family / friends	○	○	
e) I found it difficult to resume my normal social activities	○	○	
f) I had serious financial problems	○	○	
g) I argued more with my spouse / partner	○	○	○
h) I have been let down by people who I thought would stand by me	○	○	
i) I had other major problems on return from deployment	○	○	

6.13 Were any of the following a problem?

a) Loss of seniority, promotion opportunity, or responsibility	○ Yes	○ No
b) Medical classification (MEC) downgraded	○ Yes	○ No

6.14 Overall, have your experiences on YOUR LAST DEPLOYMENT TO THE MEAO made you more or less likely to continue your military career?

○ Very Likely ○ No difference ○ Less likely ○ Already Discharged

Section Six: Post Deployment Experiences

6.15 Were you married or in a significant relationship when you last deployed to the MEAO? ○ Yes ○ No - go to question 6.17

If YES: 6.16 In the weeks after you returned from your deployment:

a) How well did your partner meet your needs?	Poorly	○ 1	○ 2	○ 3	○ 4	○ 5	Extremely well
b) How good was your relationship compared to most?	Poor	○ 1	○ 2	○ 3	○ 4	○ 5	Excellent
c) How often did you wish you hadn't married or lived together?	Never	○ 1	○ 2	○ 3	○ 4	○ 5	Very Often
d) To what extent did your marriage or relationship meet your original expectations?	Hardly at all	○ 1	○ 2	○ 3	○ 4	○ 5	Completely

e) Which best described the degree of happiness, all things considered, in your relationship at the time?

○ Extremely unhappy ○ Fairly unhappy ○ A little unhappy ○ Happy ○ Very happy ○ Extremely happy ○ Perfectly happy

Please answer the following questions if you DEPLOYED AS A RESERVIST.

Otherwise, please go to Section Seven.

6.17 Were you in civilian employment at the time of your call-up for deployment?

○ Yes ○ No ○ Already in full time regular service or equivalent

6.18 Post-deployment, did you return to the same job you held before your deployment?

○ Yes
○ No, resigned at time of call-up / mobilisation
○ No, contract of employment ended just before / during deployment
○ No, employer kept job open for me but I chose not to return
○ No, employer did not keep job open for me, but I wanted to return
○ No, employer did not keep job open for me, and I didn't want to return
○ No, other reason, please specify:

6.19 Were any of the following a problem?

	YES	NO	NOT APPLICABLE
a) Loss of seniority, promotion opportunity, or responsibility in civilian job	○	○	○
b) Loss of income during call-up	○	○	○
c) Resentment from co-workers	○	○	○

Section Seven: Final Questions

As a check of our coverage in this questionnaire, please answer these final questions.

7.1 Are there other important military experiences or exposures we have not asked you about? ○ Yes ○ No

If YES: please give details in the space provided

Thank you for your time and effort in completing this questionnaire.

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By signing the Statement of Authorship, each author certifies that:

i. the candidate's stated contribution to the publication is accurate (as detailed above);

ii. permission is granted for the candidate in include the publication in the thesis; and

iii. the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

Name of Co-Author	Dr Ellie Lawrence-Wood

Contribution to the Paper	Co-Author		
Signature		Date	28.10.2019

Name of Co-Author	Associate Professor Susan Neuhaus		
Contribution to the Paper	Co-Author		
Signature		Date	~~28~~ 7.11.2019.

Name of Co-Author	Professor Alexander McFarlane		
Contribution to the Paper	Co-Author		
Signature		Date	5.11.2019

Please cut and paste additional co-author panels here as required.

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Publication

Systematic Review of The Impact of Deployment on Respiratory Function of Contemporary International and Australian Veterans'

Systematic Review of The Impact of Deployment on Respiratory Function of Contemporary International and Australian Veterans'

H Ighani, E Lawrence-Wood, SJ Neuhaus, A McFarlane

Abstract

Current international literature suggests a higher prevalence of respiratory conditions in military personnel during and following deployment to the Middle East for reasons that are not well understood. Therefore, a systematic review of research into the impacts of deployment on respiratory function among international and Australian contemporary military Veterans was undertaken.

The findings from this review suggest that deployment-related environmental, psychological trauma exposures and other military factors such as physical activity, increased tobacco use and individual susceptibility markers could contribute to respiratory conditions and other health effects not yet identified.

Key words: respiratory conditions, Middle East, military veterans, deployment, risk factors, exposure

Introduction

During the last decade, over 2.5 million United States (US) and coalition troops have deployed to Iraq and Afghanistan.[1-3] In addition to combat injuries, late health effects of operational service are well recognised [4], particularly psychological and physical effects of deployment exposures. There is also increasing evidence suggesting a higher prevalence of respiratory conditions among international military personnel deployed to the Middle East Area of Operations (MEAO).[5-7] Although no specific risk factors other than deployment have been definitively linked to these respiratory health outcomes, there are many characteristics of deployment that may raise the risk of adverse respiratory health effects, including exposure to various airborne contaminants, burn pits, dust, particulate matter, industrial fires and traumatic exposure.[5, 6] In addition, evidence suggests tobacco smoking, physical activities and other individual susceptibility factors such as age, sex, body mass index (BMI), blood pressure, physical fitness, pre-existing conditions and personal characteristics may also increase the risk of respiratory symptoms and may enhance susceptibility to environmental exposures.[8-11]

Although many studies have reported increases in respiratory conditions and symptoms among military personnel, existing knowledge regarding underlying aetiology is yet to be fully clarified. Therefore, a systematic review of research into the impacts of deployment on respiratory function among contemporary military Veterans of deployments to the MEAO was undertaken. The aim of this review was to examine the evidence regarding specific exposures and risk factors in the deployment environment that could be associated with respiratory symptoms and illnesses among military Veterans, and to ascertain whether there are unique risk factors and manifestations of respiratory health among deployed personnel. In this review, we summarise the existing published research related to the respiratory health of military personnel deployed to Iraq and Afghanistan, and examine evidence regarding associations between various deployment and other factors, and respiratory health. To provide context for the review, we first describe key respiratory health outcomes and potential exposures relevant to the military and deployed environment, and how these could be associated with respiratory health of MEAO deployed Service members. Following this, the available evidence regarding the association between

military deployment risk factors and respiratory health will be reviewed.

Methods

A systematic literature search of library databases was undertaken in May 2016, including, Embase, PubMed and Scopus. Emtree and MeSH Indexing languages were used in Embase and PubMed databases respectively (there is no indexing language available for Scopus). The following keywords were searched in titles, abstracts and texts: respiratory, respiratory tract diseases, lung disease, acute lung injuries, lung function test, respiratory function, veterans, veteran's health, military, military personnel, defence, deployment, armed conflicts, Afghan campaign 2001, Operation Enduring Freedom (OEF), Iraq wars 2003-2011,Operation Iraqi Freedom (OIF), air pollutants, environmental exposure, inhalational exposure, air environmental pollutant, combat disorder, trauma and stressor related disorder, and tobacco smoking.

To broaden the search, the reference lists of all included studies were examined to identify any other potentially relevant papers (pearling). Results were limited to studies published in English from the year 1997 to 2016.

Exclusion criteria from the initial search included:

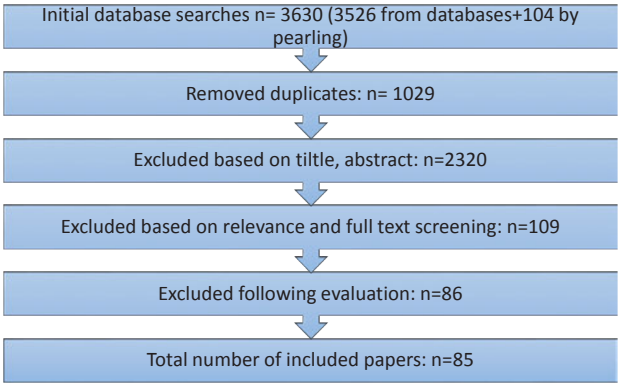
- Editorials or correspondence
- Items that were not journal articles, reviews, clinical trials, government publications or observational studies
- Languages other than English
- Published prior to 1997
- Items not published in peer-reviewed journals
- Included ages less than 18
- Items that did not involve military, veterans or servicemen
- Items that did not report respiratory problems.

Included studies were assessed on their design and level of evidence according to the Australian National Health and Medical Research Council (NHMRC) hierarchy of evidence.[12] Inclusion criteria were further refined to focus on:

- Deployed Service members or Veterans of military forces
- The impact of deployment exposures and associations with respiratory health.

Key findings of articles, country of origin, measurement, population and sample size are presented in Appendix 1. Where possible a military comparison group was preferred; however, broader criteria were used to provide the most comprehensive overview of available published research. Due to the limited research in this area, studies of lower levels of evidence addressing issues of interest were retained, although findings were interpreted with caution and used as supporting rather than primary evidence sources. A total of 172 papers were evaluated by the lead author, with ~50% n=87) also evaluated by the second author. Following this process, a total of 85 papers were included in this review (see Figure 1).

Figure 1: Studies obtained from initial database searches



Results

Preliminary assessment of studies identified the following key areas where the impact of deployment on these respiratory outcomes could be examined.

- **Environmental and/or chemical exposures** including; particulate matter (including metal particles), burn pits and air pollution
- **Trauma and combat exposures** including; blast, trauma/stress
- **Other exposures/factors** including; physical activity, smoking and individual susceptibility factors.

Papers were grouped accordingly. An assessment of the available evidence was summarised for each outcome, and conclusions regarding the state of evidence in the area as a whole presented, including an overview of notable gaps. Key study information and findings, organised by topic, are summarised in Appendix 1.

Respiratory health outcomes in deployed military populations

International studies have documented an increased incidence of respiratory disorders in military personnel who served in the Middle East compared with non-deployed populations.[5-7] Overall, studies have reported increased rates of non-specific respiratory symptoms, asthma and constrictive bronchiolitis in deployed military personnel, with evidence that exposures while on deployment contribute to this via direct actions and by disturbance of the immune system.

In a study of the causes underlying respiratory symptoms in military personnel returning from duty in Iraq and Afghanistan by Morris et al. (2013), 42% of US Veterans reported non-specific respiratory symptoms, although most did not reach the threshold for a specific clinical diagnosis.[13] The majority of patients who did receive a specific diagnosis had evidence of asthma or nonspecific airway hyper-reactivity. This may have reflected aggravation of pre-existing disease[13] or hyper-activation of the immune system.[14] Smith et al. (2009) also reported that deployment was associated with respiratory symptoms in both US Army and Marine Corps personnel, independent of smoking status and deployment length was positively associated with increased symptom reporting in Army personnel. This study concluded that specific exposures rather than deployment in general are determinants of post-deployment respiratory illness.[6] Further recent US studies have also implicated inhalational exposures during deployment as predictors of constrictive bronchiolitis and new-onset asthma in Veterans.[15, 16]

In this review, we describe the most prevalent respiratory health outcomes reported among military personnel including asthma, constrictive bronchiolitis (CB), chronic obstructive pulmonary disease (COPD), respiratory infection and acute eosinophilic pneumonia (AEP).

Asthma

Asthma, a form of reversible bronchospasm, is usually connected to allergic reaction or other forms of airway hypersensitivity. Given the nature of deployment exposures, deployed populations may be at risk of increased inflammation, which in turn can impact on respiratory function.[17] Since 2004, US military candidates diagnosed with asthma after the age of 13 have been excluded from military enlistment unless exempted via medical waiver.[16] Entry to the Australian Defence Force (ADF) for people with asthma similarly changed post 2007. Currently candidates with mild asthma may be considered for entry to the ADF subject to certain criteria, including normal spirometry and negative bronchial provocation testing.[18] However, rates of asthma among serving military personnel are generally low, in comparison to the general population. Despite low asthma rates at intake into the military, asthma diagnoses have increased in the US military since the beginning of the Iraq Afghanistan war.[6, 19] The US Department of Defense reported that 13% of US Army Medical visits in Iraq were for new-onset acute respiratory illness.[16]

Recently, an increasing number of studies have reported consistent positive associations between psychosocial stress and asthma[6, 13, 16, 20] suggesting that, in the context of military service and deployment specifically, both environmental exposures and also the psychological stress of deployment should be considered as important contributing factors. In relation to deployment specifically, several studies provide evidence of an association between deployment and new-onset asthma and other respiratory symptoms.[6, 16, 19] A retrospective review of medical diagnoses by Szema et al. (2010) of more than 6 000 US military personnel deployed and subsequently discharged from military active duty, reported that deployment to Iraq was associated with a higher risk of having a new International Classification of Diseases-9 (ICD-9) diagnosis of asthma post deployment.[16] Similar findings were documented in occupationally exposed first responders to the World Trade Center disaster.[21-23]

In a case control study, Abraham et al. (2012) reported an increase in post-deployment respiratory symptoms and medical encounters for obstructive pulmonary diseases, relative to pre-deployment rates, in the absence of an association with cumulative deployment duration or total number of deployments, indicating that it may be more specific exposures having an impact rather than deployment alone.[24] However, in contrast, DelVecchio et al. (2015) evaluated 400 US Army personnel with a clinical diagnosis of asthma and found that there was no significant relationship between rates of diagnosis or severity based on history of deployment.[25] The findings from this retrospective study may indicate that deployment-related lung conditions are subtle and require careful evaluation over time to determine the long-term impacts of deployment on the development of respiratory disease. Furthermore, this study did not focus on deployment-related environmental exposures, which may explain why no association was found.

Despite screening processes in many international militaries, pre-existing disease may also play a role

in the development of respiratory symptoms. In a prospective study Morris et al. (2007) examined airway hyper-reactivity in asymptomatic US military personnel.[19] Asymptomatic airway obstruction had a prevalence of 14% in young military personnel with evidence of worsening obstruction during exercise. This suggests that rates of asymptomatic asthma may be higher than previously recognised. Results of a cross-sectional study by Roop et al. (2007) suggested that asthmatics with good baseline symptom control are similar to non-asthmatics in their risk of developing worsening respiratory symptoms or functional limitations during deployment.[26]

Overall some studies show increased rates of asthma, which may or may not be related to deployment. There are also suggestions that asymptomatic asthma may be underestimated, therefore deployment could possibly be exacerbating, rather than causing the condition. However, in the absence of mandated pre-enlistment lung function testing, it is difficult to determine the true prevalence of asthma or hyper-reactive airways in the enlistment population.

Constrictive bronchiolitis (CB)

Constrictive bronchiolitis (CB) is a recognised form of non-reversible obstructive lung disease in which bronchioles are compressed and narrowed by fibrosis and/or inflammation. In a descriptive case series by King et al. (2011), 49 soldiers that returned from the Middle East with unexplained respiratory symptoms underwent lung biopsy.[15] Thirty-eight of these soldiers subsequently received diagnosis of CB, an otherwise uncommon diagnosis. The majority of biopsy samples showed polarisable material consistent with the inhalation of particulate matter, even though most of the soldiers were lifelong non-smokers. In addition, thickening of the arteriolar wall or occlusion in adjacent arterioles was observed, which may have been the result of toxic inhalation.

Chronic obstructive pulmonary disease (COPD)

A small number of participants in a prospective study of Australian military personnel deployed to the MEAO were found to meet the global initiative for COPD criteria. A slight but statistically significant change to lung function between pre-and post-deployment was also observed among this group, specifically between small decreases in the lung function and reported exposure to different chemical and/or environmental exposures.[1] In a retrospective review by Matthews et al. (2014), military personnel diagnosed with COPD were investigated. Despite evidence of increased respiratory symptoms in deployed military personnel, this study reported that the impact of deployment on increased diagnosis or severity of COPD appears minimal.[27]

Infection

Respiratory infections are the leading cause of outpatient treatment during deployment and account for 25–30% of infectious disease hospitalisations in US Army personnel.[28, 29] Soltis et al. (2009) found that 39% of soldiers have had at least one respiratory infection while on deployment.[30] The deployment environment may facilitate transmission of respiratory infections, thereby accounting for higher incidence rates than comparable civilian populations. Service members may be exposed to high level of stress, contagious novel pathogens, harsh environmental conditions[31] as well as overcrowding and inadequate hand-washing facilities.[32] Respiratory bacteria and viruses are transmitted person-to-person via respiratory droplets, and typically result in acute self-limiting infections.[33] However, highly virulent and transmissible strains of pathogens can lead to morbidity and mortality.[34]

Combat training programs are demanding, involving not only prolonged periods of physical activity but also exposure to psychological stressors, sleep deprivation, shifts in daily rhythm, and exposure to thermal extremes and high-altitude environments. The effects of such challenges on a soldier's health are complex, resulting in a broad spectrum of changes in the immune system, which may predispose to various diseases, predominantly of the respiratory tract.[8] Although recent attention has been directed towards acute morbidities as a result of respiratory infections, the adverse long-term effects of respiratory infections are not well understood, specifically in military populations. Given the potentially high rates of respiratory infection in deployed personnel, this is an important area for further research.

Acute Eosinophilic pneumonia (AEP)

Acute eosinophilic pneumonia (AEP) is an uncommon, idiopathic lung disease. The diagnosis is typically based upon clinical testing that include bronchoalveolar lavage, blood test or smear and chest radiograph. Lung biopsy is rarely necessary. AEP is characterised by general respiratory symptoms, alveolar and or blood eosinophilia, and peripheral pulmonary infiltrates on chest imaging.[35] In most cases the acute illness lasts less than four weeks. Dry cough, dyspnoea and fever are present in almost every patient. Associated symptoms and signs can include malaise, myalgia, night sweats, chills and chest pain.[35] Some studies suggest that AEP is an

acute hypersensitivity reaction to an unknown inhaled antigen in an otherwise healthy individual.[36] Eighteen cases of AEP (including two fatalities) were reported among over 180 000 military personnel deployed in or near Iraq between March 2003 and March 2004. All AEP patients were smokers with 78% recently beginning to smoke during deployment and all but one patient had significant exposure to fine airborne sand or dust; no other common source exposure could be identified. The study concluded that 'recent exposure to tobacco may prime the lung in some way such that a second exposure or injury, eg, in the form of dust, triggers a cascade of events that culminates in AEP'.[5, 37] AEP was also reported in at least one firefighter following the collapse of the World Trade Center towers in 2001.[38]

As outlined above, current literature, including case reports and retrospective cohort studies, suggest a potentially higher prevalence of respiratory symptoms and respiratory illnesses including asthma,[5, 16, 26] CB,[15] COPD,[1, 39] and AEP[37] among deployed military personnel. Specific deployment-related exposures such as environmental (particulate matter, metal particles, burn pit, air pollution), combat (blast, stress) and other exposures (smoking, physical activity, military living conditions) may relate to these impairments in respiratory function[5, 10, 11, 15, 37, 40-44] and are discussed below.

Environmental and/or chemical exposures

Military personnel who have served in Iraq and Afghanistan have expressed concern about possible long-term health effects associated with environmental exposures during deployment, including toxic industrial chemicals, local combustion sources and poor air quality.[5, 41, 42, 45-47] US Veterans seeking treatment at Department Veterans Affairs (DVA) clinics after deployment, have reported a high prevalence of environmental exposure and exposure concerns, although whether this concern translates to actual adverse respiratory health outcomes is unclear.

In line with these concerns, researchers have hypothesised that there may be a relationship between deployment exposures and respiratory symptoms.[21, 43, 46, 47] Korzeniewski et al. (2013) reported that the prevalence of respiratory diseases was closely related to environmental factors on deployment, such as exposure to sand and dust storms, extreme temperature changes and poor public health measures.[7] A medical research working group formed to consider lung disease in US soldiers returning from Iraq and Afghanistan identified a number of potential risks for developing lung disease post deployment. These include type, severity and duration of exposure to environmental hazards, such as desert dust storms, proximity and duration of exposure to burn pits or fires, and frequency of exposure to air pollution.[5]

Air pollution

Air sampling studies, conducted by US researchers suggest that multiple sources of air pollution including smoke from oil well fires, sand and dust storms, and not exclusively burn pit emissions, contribute to poor air quality in the deployed environment.[46, 48] These findings are supported by independent work from investigators outside of the US;[47-49] however, there is no data available from longitudinal research studies with objective pulmonary assessments comparing lung function between those deployed to the Middle East and non-deployed personnel. A review article by Falvo et al. (2015) summarised current knowledge about the impact of service and environmental exposures on respiratory health of military Service members deployed to Iraq and Afghanistan.[21] The report reviewed 19 studies published from 2001 to 2014. While studies of environmental exposures, in particular airborne pollutants, have shown an association with an increased burden of acute respiratory symptoms, studies reporting chronic respiratory diseases do not provide conclusive results, mainly because of the non-representative sample of the study populations. Data associating airborne hazard exposures to respiratory disease are similarly inconclusive. Therefore, there is insufficient evidence to support any association between air pollution in the deployed environment and respiratory health of military personnel.[21]

Particulate matter (PM)

US data suggests that deployment to both Iraq and Afghanistan may pose additional risk factors to respiratory health because of the high levels of airborne PM and geologic dusts inherent in those regions.[50] A majority (94%) of US Service personnel deployed to OIF and OEF reported exposure to high levels of airborne PM from a range of sources that may have exceeded environmental, occupational and military exposure guidelines,[43, 51] indicating that these pose a real risk to health. McAndrew et al. (2012) reported that among MEAO deployed personnel, the most prevalent exposures were air pollution (94%), vaccines (86%) and petrochemicals (81%).[43] Exposures and concern about exposures were both related to greater somatic symptom burden, and concern about exposure was highly correlated with symptom burden.

Metal particles

Another exposure of relevance to the deployed environment is metal PM. Biopsied lung tissue from selected deployed US soldiers with unexplained respiratory symptoms and history of inhalational exposure, identified the presence of metals including iron, titanium and crystalline material. This deployment's inhalational exposure was thought to be the cause of unexplained exertional dyspnoea and diffuse CB conditions in these soldiers.[15] Exertional dyspnoea is excessive shortness of breath and mainly reflects poor ventilation or oxygen deficiency in circulating blood. CB is a rare, small airway fibrotic respiratory disease. The cause of this condition is still unknown, although it is thought that environmental factors and genetic susceptibility could be major contributors to the development of the disease.[52] King et al. (2011) found that in 38 of 49 previously healthy soldiers with unexplained exertional dyspnoea and diminished exercise tolerance after deployment, an analysis of biopsy samples showed diffuse CB, possibly associated with inhalational exposure.[15]

Burn pit

A further identified exposure for respiratory insult, again common in the MEAO, is open-air burning of rubbish and other waste. Although the extent of the chemicals released in burn pits is unknown, ambient air sampling performed in selected Middle East regions has revealed that smoke from burn pits is a major source of air pollution.[42] Some air pollutants such as dioxins, carbon monoxide, volatile organic compounds from burning of trash, vehicle/generator exhaust, oil well fires, gases from industrial facilities, and contaminants from dust containing silica, asbestos, lead, aluminium and manganese are well recognised carcinogens. Other agents may irritate the respiratory system causing acute cough or shortness of breath, hypersensitivity pneumonitis, irritant induced asthma and CB, especially when exposures are repetitive or exceed recommended concentrations.[45]

Evidence to support long-term adverse effects of exposure to burn pits is controversial. Although some studies have found that deployment may be associated with a subsequent risk of developing respiratory conditions. Abraham et al. (2014) suggests that elevated medical encounter rates (visits to medical centres for respiratory outcomes including general respiratory system and other chest symptoms, asthma, COPD, bronchitis, emphysema, bronchiectasis and extrinsic allergic alveolitis) were not uniquely associated with burn pits.[42] In this study, medical encounter rates among personnel deployed to burn pit locations were compared directly to those among personnel deployed to locations without burn pits. No significant differences in respiratory outcomes between these groups were found.

Furthermore, findings from Smith et al. (2012) do not support an elevated risk for respiratory outcomes among personnel deployed within proximity of documented burn pits in Iraq.[45] Comparing burn pit exposed and non-exposed groups, this study observed similar proportions of newly reported CB and emphysema (1.5% vs 1.6% respectively), newly reported asthma (1.7% vs 1.6%), and respiratory symptoms in 2007 (21.3% vs 20.6%). Similarly, a study by Baird et al. (2012) reported that while potential exposure to sulphur plant fires was positively associated with self-reported health concerns and symptoms, it was not associated with an increase in clinical encounters for chronic respiratory health conditions.[44] Powell et al. (2012) found no increase in chronic multi-symptom illness (CMI) symptom reporting in military personnel deployed to three selected bases with documented burn pits compared with other deployment sites.[53] However, limitations in standardising exposures may have biased these results.

Toxicological, epidemiological and clinical data are limited and prevent reliable evaluation of the prevalence or severity of adverse effects of inhalational exposures to PM or burn pit combustion products in military personnel deployed to Iraq and Afghanistan. The current clinical evidence on the effect of deployment on respiratory health is primarily retrospective and does not provide clarity regarding specific causative factors or the effect on the deployed population as a whole.[21] Taken together, these findings suggest that environmental exposures including burn pits and air pollution may be associated with subjective physical health symptom reporting, but there is no evidence of increased rates of objective respiratory health outcomes.

Regardless of the source, it seems likely that higher levels of air pollution are common in many deployment areas and could contribute to future pulmonary and other health effects not yet identified.[48] Together, these findings indicate that while deployment appears to be associated with adverse respiratory outcomes, this cannot be reliably attributed to environmental exposures. Other deployment exposures that should also be considered include trauma, particularly blast trauma and psychosocial stress associated with a combat environment.

Combat exposures

Blast

In addition to air pollution and smoke from burn pits, military Veterans who have served in Iraq and Afghanistan may have been exposed to other significant respiratory stressors, such as aerosolised metals and chemicals from improvised explosive devices (IEDs), or to traumatic respiratory insult such as blast overpressure or shock waves to the lung.[54]

Concern about the effects from embedded metal fragments from IEDs used in the Middle East conflicts has been raised among Service members. As a result, the US DVA established a special registry in 2008 for medical surveillance and management of Veterans with retained metal.[51] Some of the embedded metal contaminants, including aluminium, arsenic, cobalt, chromium and nickel, may have immunogenic respiratory health effects. In a recent report from the Toxic Embedded Fragment Surveillance Centre, of 89 urine samples tested, 47% exceeded the reference value for aluminium and 31% for tungsten.[55]

Recently, publication of an unusual case report of chronic beryllium disease (CBD) was described in a 41-year-old Israeli soldier who suffered mortar shell injury with retained shrapnel in the chest wall. This report raised the possibility of shrapnel- induced CBD from long-term exposure to the surface of retained aluminium shrapnel fragments in the body.[56]

It has been proposed that Service members who sustained subclinical blast injury may be susceptible to long-term sequelae. Apart from direct consequences of blast injuries such as blast pressure wave, fragments of debris or injuries due to acceleration or deceleration, there are also less obvious injuries caused by a blast including psychological trauma, burns and toxic-substance exposure from inhalation of hot contaminated air.[57,58] Such injuries can have unpredictable long-term outcomes including permanent fibrosis of the bronchial mucosa.[59]

Despite the high plausibility of long-term adverse effects following acute pulmonary blast injury, there is an absence of data on the long-term outcomes. Furthermore, the possibility of other long-term pulmonary consequences of blast exposure, such as the effect of explosion-related dust exposure, and other exposures such as smoking, has not been adequately examined. Overall there is limited data to support a conclusion regarding an association between exposure to blast and long-term respiratory outcomes.[57]

Trauma/stress

In addition to the frequent and proximate exposures to ambient airborne hazards, factors unique to military service that may make military personnel more vulnerable to greater respiratory health risk include high levels of psychological stress.[21] Vocal cord dysfunction (VCD) refers to abnormal closing of the vocal cords when inhaling or exhaling. It is often misdiagnosed as asthma in the clinical setting and has been reported in military personnel.[50] A study of exertional dyspnoea in US military personnel demonstrated that 12% of patients evaluated had evidence of VCD, most of which was exercise related. Morris et al. suggested that the development of VCD in the deployed environment might be related to nonspecific upper airway irritation, underlying psychiatric conditions and/or significant stress attributed to the combat environment.[50]

There is also growing evidence for an association between exposure to traumatic stress, including childhood maltreatment or combat experience and pulmonary diseases such as asthma, CB and COPD.[60-63] This relationship was also demonstrated in adult research populations exposed to the 11 September 2001 World Trade Center terrorist attack. More specifically, moderate associations between probable post-traumatic stress disorder and respiratory symptoms have been observed in first responders to the World Trade Center disaster.[22, 23, 60, 64]

A cross-sectional study conducted by Spitzer et al. (2011), analysed the associations between lung function, trauma exposure and post-traumatic stress disorder (PTSD) in 1 772 adults from the general population using standardised questions and spirometry test.[60] Those with a diagnosis of PTSD had a significantly greater risk of having asthma symptoms than those without PTSD. However, those with a history of psychological trauma, but no diagnosis of PTSD, did not have an elevated risk, suggesting the association is specific to disorder status rather than symptomatology or trauma exposure. Analyses indicated that subjects with diagnosed PTSD had a significantly increased risk for airflow limitation independent of its definition.

One possible mechanism underpinning the association between stress and reduced respiratory function could be increased levels of systemic inflammatory markers.[20, 65-68] Excessive pro-inflammatory responses may cause airway damage and consequently structural and functional pulmonary changes.[31] Hypothetically, higher levels of stress during deployment among personnel may,

in part, explain the increased rate of respiratory symptoms reported in recent studies. There is increasing evidence of associations between stress related mental disorders such as PTSD and altered immune responses, and elevated circulating inflammation. The direction of this association is not conclusive, however. Regardless, low level inflammation and altered immune response provide plausible mechanisms by which trauma exposure may be associated with respiratory symptoms.[20, 60, 65-68]

Other exposure factors

In addition to deployment specific risks, evidence suggests other military factors such as physical activity, increased tobacco use and other individual susceptibility factors may increase the risk of respiratory symptoms and enhance susceptibility to environmental and trauma exposures in this population.

Physical activity

Researchers have suggested that physical activity performed in stressful environments alters immune function.[17] Light physical activity or moderate environmental stress stimulate immune responses, but exhausting physical activity or severe environmental stress can have immune suppressant effects, manifested by a temporary increase in susceptibility to respiratory infections.[9] Multiple physical and psychological stressors, such as those encountered on deployment, may induce alterations in immune parameters (as discussed above) and/or neurological and endocrine responses; these common exertion-induced pathways could result in respiratory tract syndromes.[8]

Smoking

Cigarette smoking has been associated with morbidity and mortality in a number of studies.[5-7, 21, 31, 69, 70] Pathological mechanisms of smoking and its adverse health effects generally overlap with environmental air pollution. Smoking has also been related to increased susceptibility to respiratory insult from airborne hazards.[70] Interestingly, there is no clear evidence of direct effects of smoking on respiratory outcomes in deployed military populations. For example, Sanders et al. found that approximately 70% of US military personnel deployed to Iraq and Afghanistan reported at least 1 episode of an acute respiratory illness and 15% reported 3 or more incidents of respiratory illnesses during their deployment.[31] There was, however, no observed relationship between cigarette smoking and self-reported respiratory illnesses during deployment; suggesting that factors other than tobacco use were likely to contribute to the observed respiratory symptoms and morbidity.

Findings from a prospective study of Australian military personnel deployed to the MEAO showed that those respondents who began or resumed smoking while on deployment were also likely to have more co-morbidities compared to those who did not smoke on deployment.[1] Similarly, those who smoked more than usual were likely to have more co-morbidities compared to those who did not smoke.[1] However, the relative impact of different exposures and other non-smoking related risk were not examined in this population.

Since the 1960s, the rate of tobacco smoking has declined in the US including in the military.[71] However, the rate of tobacco smoking among active duty military personnel remains higher (32%) compared to the general population (~20%).[71] Within the US military population, the prevalence of smoking is approximately 40% higher among Veterans and 50% higher among deployed military personnel compared with their non-deployed counterparts.[71] In a cross-sectional study by Sanders et al. (2005), it was reported that 47.6% of US military personnel deployed to Iraq and Afghanistan began or resumed smoking while deployed and ~40% smoked half a pack of cigarettes or more per day.[31] High rates of tobacco smoking are not restricted to US military personnel but are also increased 40%–60% among coalition militaries.[72]

While specific factors contributing to smoking rates have not been ascertained, the significant smoking uptake observed in a number of studies is thought to relate to deployment stress particularly among those with prolonged deployments, or combat exposures.[73] Combat exposure, military stressors and PTSD have all been identified also as predictors for cigarette smoking.[74, 75] As discussed above, these psychological risk factors and mental health disorders have also been associated with respiratory symptoms, abnormal lung function and diseases such as asthma.[20, 76] Although tobacco smoke may differ in many respects from the ambient air pollution in deployed settings, the contribution of tobacco smoke exposure to military personnel's cumulative exposures to airborne hazards while on deployment cannot be underestimated, given the prevalence and intensity of tobacco use in stressful combat situations.[21] The potential for smoking to interact with and/or exacerbate other environmental or stress exposures is of importance to examine.

Individual susceptibility factors

Studies regarding the association between respiratory health conditions and individual factors (age, sex, BMI, blood pressure, physical fitness, pre-existing conditions and personal characteristics) in general the population and deployed military personnel generally focus on single respiratory outcomes and are usually assessed using different methods.

In a cross-sectional study, data collected from a European Community Respiratory Health survey of 16 countries were examined. The aim of this study was to estimate the age and sex-specific incidence of asthma from birth to the age of 44 in men and women across several countries, and to evaluate the main factors influencing asthma incidence in young adults. This study demonstrated that there are different patterns of asthma incidence in men and women. During childhood, girls had a significantly lower risk of developing asthma than did boys. Around puberty, the risk was almost equal in the two sexes, while after puberty, the risk in women was significantly higher than that in men.[77]

In a case control study of active duty and retired US military members, increasing BMI, younger age, gender, non-active duty beneficiary status and arthritis were significant independent predictors of asthma in this population.[78] Similarly, Abraham et al. (2012) reported that gender, enlisted and Army personnel remained independent predictors of having a new obstructive pulmonary disease encounter.[39] Age and combat occupations were not statistically significantly associated with a post-deployment obstructive pulmonary disease diagnosis. The way in which these factors might interact with deployment exposures to influence respiratory health outcomes has not been thoroughly studied. This deserves further attention in larger epidemiological studies, particularly given emerging evidence of their influence on physical and psychological health.

Limitations

Due to the limited research regarding respiratory health of MEAO deployed Service members, studies of lower levels of evidence addressing issues of interest were discussed in this review, although findings were interpreted with caution and used as supporting rather than primary evidence sources.

A number of studies in this review were of cross-sectional design; consequently, any respiratory health issues in existence before an exposure were not accounted. Without baseline data, it is not possible to accurately assess the impact of specific deployment exposures on a person's respiratory health. Cross-sectional studies are carried out at one period and do not indicate the series of events, therefore it is difficult to determine the relationship between exposure and outcome as it lacks the time element.

Previous studies have largely relied on self-report data to measure the impact of exposures on respiratory health. This type of measurement is open to recall bias, particularly when data is collected well after exposures have occurred.[31, 26] Medical record reviews are predominantly retrospective[7, 16, 39] and therefore also subject to potential biases (reflected in documentation and health care seeking).

Discussion

Long-term psychological and physical health effects following deployment are of concern to Veterans, healthcare providers and the community. While some international literature suggests a higher prevalence of respiratory conditions in military personnel during and following deployment to the Middle East, findings are equivocal and the exact reasons underpinning any elevated respiratory health consequences are not well understood. Some inconsistencies in findings could be due to difficulties retrospectively standardising for exposure; reliance on self-reported symptoms or conditions, or inconsistent application of ICD codes, making it difficult to say with certainty which conditions are increasing in incidence or prevalence. Furthermore, many studies have focused on limited exposure and outcome variables. The potential interaction of these factors, and their effects on multiple respiratory outcomes, has not been thoroughly considered.

Current evidence (mainly from US studies) indicates that deployment-related environmental (PM, burn pit, air pollution, metal particles), combat (blast, stress) and other exposures (smoking, physical activity, military living conditions), and psychological trauma more generally, may be associated with several respiratory conditions in military personnel, such as asthma,[5, 16, 26] CB,[15] COPD,[1, 39] sinusitis,[40] and AEP[37]. These associations may be via direct actions and by disturbance of the immune system. Psychological stress, while highly prevalent in relation to deployment, is a less investigated risk factor for respiratory health outcomes and its contribution to respiratory health outcomes and potential mechanisms underlying associations, as well as potential predictors of good or poor health over time, are not well understood.[61, 68, 79-85]

Taken together, further prospective and cross-sectional analyses are needed to clarify relationships

between the individual and combined impacts of environmental and psychological exposures on deployment, and any potential moderating or mediating effects of other factors on respiratory outcomes.

Corresponding author: Honey Ighani, honey.ighani@adelaide.edu.au
Authors: H. Ighani [1,2], E. Lawrence-Wood [1,2], S. J. Neuhaus [1], A. McFarlane[1,2]
Author Affiliations:
1 The University of Adelaide
2 Centre for Traumatic Stress Studies

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Appendix 1. Key findings of the systematic review of the impact of deployment on respiratory function of contemporary international and Australian Veterans

Environmental, chemicals, other exposures

Author	Title	Year	Country	Measurement	Design	Level of evidence	Population	Sample size	Key Findings
8 Korzeniewski K	Environmental factors, immune changes and respiratory diseases in troops during military activities	2013	Poland	NA	Literature review	NA	NA	NA	- The effects of deployment challenges on a soldier's health are complex - Could result in a broad spectrum of changes in the immune system and numerous cases of various diseases, with a predominance of respiratory tract infections.
22 Banauch IG	Persistent Hyperreactivity and Reactive Airway Dysfunction in Firefighters at the World Trade Center	2003	USA	- Presence of bronchial hyperreactivity - Respiratory objective measures at 1, 3 and 6 months post exposure	Retrospective cohort	III-2	- World Trade Center (WTC) rescue workers	- 179	- Development and persistence of hyper-reactivity and reactive airways dysfunction were strongly and independently associated with exposure intensity - Hyper-reactivity shortly post-collapse predicted reactive airways dysfunction at 6 months in highly exposed workers
23 Glaser MS	Estimating the Time Interval Between Exposure to the World Trade Center Disaster and Incident Diagnoses of Obstructive Airway Disease	2014	USA	- Demographic data (FDNY employee database) - Physician diagnoses (electronic medical records) - Self- reported health questionnaires, obtained information regarding WTC exposures, smoking status, and current respiratory symptoms	Prospective cohort	II	- FDNY firefighters who first arrived at the WTC site	- 8 930	- There were higher rates of new-onset obstructive airway disease (OAD) among the high exposure group during the first 15 months and, to a lesser extent, throughout follow-up
24 Abraham JH	A Case-Crossover Study of Ambient Particulate Matter and Cardiovascular and Respiratory Medical Encounters Among US Military Personnel Deployed to Southwest Asia	2012	USA	- Personnel and medical record -Meteorological data - ICD-9 codes - Linked ambient PM data with personnel, medical and meteorological data	Case-crossover	III-1	- US military personnel in southwest Asia	- 2 838 cases	- No statistically significant associations between PM and cardiorespiratory outcomes were observed in young, relatively healthy, deployed military population

41 Engelbrecht JP	Characterizing Mineral Dusts and Other Aerosols from the Middle East—Part 1: Ambient Sampling	2009	USA	- Scanning electron microscopy with energy dispersive spectroscopy was used to analyse the chemical composition of small individual particles	Air sampling	NA	NA	NA	- This study shows the three main air pollutant types to be geological dust, smoke from burn pits and heavy metal condensates (possibly from metals smelting and battery manufacturing facilities)
42 Abraham JH	A Retrospective Cohort Study of Military Deployment and Post-deployment Medical Encounters for Respiratory Conditions	2014	USA	- Medical record review, ICD-9 codes 490–496, 786	Retrospective cohort	III-2	- Active US military personnel (OIF)	- 18 430 deployed with burn pit exposure - 6 337 deployed without burn pit exposure - 157 053 non deployed	- OIF deployment is associated with subsequent risk of respiratory conditions - Elevated medical encounter rates were not uniquely associated with burn pits
43 McAndrew LM	Environmental Exposure and Health of Operation Enduring Freedom/Operation Iraqi Freedom Veterans	2012	USA	-16-item self-report exposure measure created by a WRIISC Occupational and Environmental Medicine physician	Cross-sectional	IV	- USA OEF/ OIF veterans seen at the Department of Veterans Affairs NJ WRIISC, a tertiary specialty care clinic	- 469	- OEF/OIF veterans seeking treatment at a DVA clinic reported a high prevalence of environmental exposures and exposure concerns. Both negatively impacted health outcomes
44 Baird CP	Respiratory Health Status of US Army Personnel Potentially Exposed to Smoke From 2003 Al-Mishraq Sulphur Plant Fire	2012	USA	- Health survey questionnaire - ICD-9 codes at pre- and post-deployment	Retrospective cohort	III-2	- US army personnel	- 6 352 potentially exposed to sulphur fire; - 4 153 not exposed	- Potential exposure to the sulphur fire was positively associated with self-reported health concerns and symptoms - Not associated with clinical encounters for chronic respiratory health conditions
45 Smith B	The Effects of Exposure to Documented Open-Air Burn Pits on Respiratory Health Among Deployers of the Millennium Cohort Study	2012	USA	- Health survey questionnaire at baseline and follow-up	Retrospective cohort	III-2	- US Army and Air Force personnel	- 22 297 - 3 585 were within 3 miles of burn pit	- Findings do not support an elevated risk for respiratory outcomes among personnel deployed within proximity of documented burn pits in Iraq - No increased risks if deployed within 3 miles of burn pit
46 Helmer DA	Health and exposure concerns of veterans deployed to Iraq and Afghanistan	2007	USA	- Review of clinical notes in the DVA Computerized Patient Record System (CPRS)	Retrospective	III-2	- OIF and OEF veterans consecutively evaluated at the NJ WRIISC from June 2004 to January 2006	- 56	- Veterans of military operations in Southwest Asia have deployment-related health and exposure concerns - This will need to be addressed by their ambulatory care physicians

47 Magnusson R	Broad Exposure Screening of Air Pollutants in the Occupational Environment of Swedish Soldiers Deployed in Afghanistan	2012	Sweden	- Particulate matter (PM10 and PM2.5), polycyclic aromatic hydrocarbons (PAHs), oxygenated PAHs, n-alkanes, nitrogen dioxide (NO2), sulfur dioxide, toxic metals, and volatile organic compounds (VOCs) - Samples were collected for 14 consecutives 24 hr periods at two military camps in Afghanistan, Camp Northern Lights (CNL) in Mazar-e Sharif and the ISAF Headquarters in Kabul	Active air sampling	NA	NA	NA	- High concentrations of PM were identified as the main potential health hazard, with PM2.5 and PM10 exceeding both long-term marginal Air-MEGs and short-term negligible Air-MEGs outdoors - In Kabul, the organic chemical composition of particulates revealed high levels of PAHs and oxy-PAHs, which are toxic combustion-related pollutants
49 Wingfors H	Characterization of the size-distribution of aerosols and particle-bound content of oxygenated PAHs, PAHs, and n-alkanes in urban environments in Afghanistan	2011	Sweden	- Particulate matter (PM10 and PM2.5), PAHs, oxygenated PAHs, n-alkanes, NO2, sulfur dioxide, toxic metals, and VOCs - Samples were collected for 14 consecutives 24 hr periods at two military camps in Afghanistan, CNL in Mazar-e Sharif and the ISAF Headquarters in Kabul	As part of 'Health risks in military operations', research project	NA	NA	NA	- Characterisation of PM revealed large differences between the Afghan cities - The largest differences were the significantly higher concentrations of PAHs and oxy-PAHs, for which Kabul had the highest concentrations
53 Powell TM	Prospective Assessment of Chronic Multi symptom Illness Reporting Possibly Associated with Open-Air Burn Pit Smoke Exposure in Iraq	2012	USA	- Data from the 2004–2006 and 2007–2008 survey cycles of the Millennium Cohort Study	Prospective	II	- US deployers with at least one deployment to an area within 3 miles of a documented burn pit	- 3 578	- There was no increase in CMI symptom reporting in those deployed to three selected bases with documented burn pits compared with other deployers
59 Krzywiecki A	Late consequences of respiratory system burns	2007	Poland	- Changes in the pulmonary function tests (PFTs) after six years of follow-up in miners who survived a methane explosion	Retrospective cohort	III-2	- 41 miners fell victims to a methane explosion with documented thermal injury of the respiratory tract - 25 healthy miners who served as controls	- 41 exposed miners - 25 healthy miners	- A significant decrease in DLCO was observed in the victims (98.4% vs. 85.4%), but not in the control group - A significant decrease in FEV1 (96.4% vs. 83.4%) was observed in the control subjects - This finding is likely due to smoking and exposure to heavy pollution

64 Farfel M	An Overview of 9/11 Experiences and Respiratory and Mental Health Conditions among World Trade Center Health Registry Enrollees	2008	USA	- The WTCHR protocol, including the baseline survey completed using computer-assisted telephone interviewing (CATI) and computer-assisted in-person personal interviewing (CAPI)	Cross-sectional	IV	- World Trade Center Health Registry (WTCHR) enrollees	- 71 437	- After 9/11, 67% of adult enrollees reported new or worsening respiratory symptoms -3% reported newly diagnosed asthma, 16% screened positive for probable PTSD, and 8% for serious psychological distress - Newly diagnosed asthma was most common among rescue and recovery workers who worked on the debris pile (4.1%)
76 Luft BJ	Exposure, probable PTSD and lower respiratory illness among World Trade Center rescue, recovery and clean-up workers	2012	USA	- Data were derived from the initial examinations that took place ~4 years after 11 September 2001 - Structural equation modelling (SEM) were used to explore patterns of association among exposures, other risk factors, probable WTC-related PTSD based on PCL, physician-assessed respiratory symptoms arising after 9/11, and abnormal pulmonary functioning defined by low forced vital capacity	Cross-sectional	IV	- 8 508 police and 12 333 non-traditional responders to WTC terrorist attack	- 8 508 police -12 333 non-traditional responders	- Exposure was more strongly associated with respiratory symptoms than with PTSD or lung function - The SEM model suggested that PTSD statistically mediated the association of exposure with respiratory symptoms
79 Weese CB	Potential health implications associated with particulate matter exposure in deployed settings in southwest Asia	2009	USA	NA	Literature review	NA	NA	NA	- Paper discussed what is currently known about the effects of PM on human health, focusing on the limited evidence specific to US personnel - Outlined current and planned efforts to utilise sampling data to assess health outcomes in deployed military populations

82 Morris MJ	Diagnosis and management of chronic lung disease in deployed military personnel	2013	USA	NA	Literature review	NA	NA	NA	- Current data not adequate to reliably evaluate the prevalence or severity of adverse effects of inhalational exposures to PM or burn pit combustion products - The current clinical evidence is primarily retrospective in nature and does not provide any clear information on specific causative factors or the effect on the deployed population as a whole
Trauma/Combat exposures									
Author	Title	Year	Country	Measurement	Design	Level of evidence	Population	Sample size	Key Findings
9 Shephard RJ	Immune changes induced by exercise in an adverse environment	1998	Canada	NA	Literature review	NA	NA	NA	- Light physical activity or a moderate level of environmental stress stimulates the immune response - Exhausting physical activity or more severe environmental stress have a suppressant effect, manifested by a temporary increase in susceptibility to viral infections
20 Douwes J	Asthma nervosa: old concept, new insights	2011	New Zealand	- Editorial review	Editorial review	NA	NA	NA	- Emotional stress, anxiety and PTSD precedes the development of asthma both in children and adults - There is evidence that asthma precedes panic disorders and that panic disorders may exacerbate pre-existing asthma (adjusted for smoking, socioeconomic status, BMI and familial and genetic factors)
25 DelVecchio SP	The impact of combat deployment on asthma diagnosis and severity	2014	USA	- Electronic medical record	Retrospective	III-2	-Army personnel with a clinical diagnosis of asthma were evaluated	- 400	- Among active duty military personnel with career limiting asthma, there is no significant relationship between rates of diagnosis or severity based on history of deployment to SWA

58 Mackenzie IMJ	Blast injuries to the lung: epidemiology and management	2010	UK	- Plain chest films taken for the diagnosis of adult respiratory distress syndrome	Case series	IV	- Military casualties admitted to University Hospital Birmingham's critical care services, during the period 1 July 2008 to 15 January 2010	- 135	- The majority of casualties with blast-related lung injury have been very successfully managed with conventional ventilatory support employing a lung protective strategy - Only a small minority requiring non-conventional support in the form of high-frequency oscillatory ventilation
60 Spitzer C	Association of airflow limitation with trauma exposure and post-traumatic stress disorder	2011	Germany	- Trauma exposure, PTSD and respiratory symptoms were assessed using standardised questions - Lung function was assessed using spirometry.	Cross-sectional	IV	- Adults from the general population: with PTSD (n=28), - With trauma (n=887), - With no trauma (n=857)	- 1 772	- Findings suggest an association of trauma exposure and PTSD with airflow limitation, which may be mediated by inflammatory processes
61 Bandoli G	Psychosocial stressors and lung function in youth ages 10–17: an examination by stressor, age and gender	2016	USA	- Self-report measures - Lung function test with spirometry	Cross-sectional	III-3	- Adolescents in the Los Angeles Family and Neighborhood Survey	- 584 children aged 5 – 17	- Study observed reductions in lung function in males related to the absence of a father in the house and family conflict; - Associations were stronger in older males ages 15–17 years for each stressor
62 Goodwin R	Association between childhood trauma and physical disorders among adults in the United States	2004	USA	- Data were drawn from the National Comorbidity Survey	Cross-sectional	IV	- Individuals age 15 to 54 in the non-institutionalised population	- 5 877	- Childhood physical abuse was associated with increased risk of lung disease peptic ulcer and arthritic disorders - Childhood sexual abuse was associated with increased risk of cardiac disease - Childhood neglect was associated with increased risk of diabetes and autoimmune disorders.
63 Scott K	Childhood Adversity, Early-Onset Depressive/Anxiety Disorders, and Adult-Onset Asthma	2008	USA	- Composite International Diagnostic Interview (CIDI 3.0) as part of the World Mental Health surveys - Face to face interview	Cross-sectional	III-3	- Colombia 2104 - Belgium 980 - France 1326 - Germany 1283 - Italy 1698 - Netherlands 1017 - Spain 2006 - Japan 856 - Mexico 2064 - USA 4969	-18 303	- Childhood adversities and early-onset depressive/anxiety disorders independently predict adult-onset asthma, suggesting that the mental disorder-asthma relationship is not a function of a shared background of childhood adversity

66 Provençal N	The effects of early life stress on the epigenome: From the womb to adulthood and even before	2014	Germany	NA	Literature review	NA	NA	NA	- There is increasing evidence for a prominent role of epigenetic mechanisms in embedding long-term effect of stress at different developmental stages as well as across generations - These epigenetic mechanisms are distinct for the different stages of stress exposure
67 Ha¨ nsel A	Inflammation as a psychophysiological biomarker in chronic psychosocial stress	2010	USA	NA	Literature review	NA	NA	NA	- Job stress, low socioeconomic status, childhood adversities as well as life events, caregiver stress and loneliness were all shown to exert effects on immunologic activity
68 Wright RJ	Epidemiology of Stress and Asthma: From Constricting Communities and Fragile Families to Epigenetics	2011	USA	NA	Epidemiological review	III-2	NA	NA	- Evidence increasingly links psychosocial stress to asthma, atopic disorders more broadly and lung function
85 Carroll D	Generalized Anxiety Disorder is Associated With Reduced Lung Function in the Vietnam Experience Study	2011	USA	- One-year prevalence of Generalized Anxiety Disorder (GAD) and major depressive disorder (MDD) was determined using DSM-III criteria - Forced expiratory volume in 1 second was measured by spirometry	Cross-sectional	III-2	- Participants from the Vietnam Experience Study Entered military service between 1965-1971; served only one term of enlistment; served at least 16 weeks of active duty	- 4 256	- In models that adjusted for age and height, both GAD (p=0.001) and MDD (p = 0.004) were associated with lower FEV1 - In models additionally adjusting for weight, service, ethnicity, marriage, smoking, alcohol consumption, income, education and major illness, GAD was still associated with poorer lung function (p = 0.01), whereas MDD was not (p =0 .18)

Other exposures/factors									
Author	Title	Year	Country	Measurement	Design	Level of evidence	Population	Sample size	Key Findings
11 McKinney WP	Comparing the Smoking Behavior of Veterans and Nonveterans	1997	USA	- Self-reported questionnaire data from the 1987 - National Medical Expenditure Survey (NMES)	Cross-sectional	III-3	- Random sample of veterans and the civilian, non-institutionalised population of the United States.	- 3 372 veterans vs 18 606 non-veterans - 133 female veterans vs 12 063 female nonveterans - 173 veterans using DVA system vs 2 218 veterans who sought care elsewhere.	- The likelihood of ever having smoked cigarettes was higher for veterans than for non-veterans and for women veterans than for women non-veterans. - The prevalence of current smoking was higher for veterans than for non-veterans and higher for those seeking care within the DVA system than for other veterans.
72 Bray I	Smoking prevalence amongst UK Armed Forces recruits: changes in behavior after 3 years follow-up and factors affecting smoking behavior	2013	UK	- Survey of the health behaviours	Cohort 3 years follow-up		- UK recruits in 1998/1999	- 10 531	- There were clear differences between service, rank and trade groups in smoking prevalence at recruitment - Smoking levels increased in the 3 years after recruitment to the Armed Forces.
73 Smith B	Cigarette Smoking and Military Deployment A Prospective Evaluation	2008	USA	-The incidence of new smoking in baseline never-smokers and the prevalence of resumed smoking in baseline past smokers were calculated	Prospective	II	- US military personnel	- 48 304	- Military deployment is associated with smoking initiation and, more strongly, with smoking recidivism, particularly among those with prolonged deployments, multiple deployments or combat exposures
74 De Silva VA	Smoking among troops deployed in combat areas and its association with combat exposure among navy personnel in Sri Lanka	2012	Sri Lanka	- The 28 page questionnaire used in the study "Health of UK military personnel deployed to the 2003 Iraq war" was used as the data collection instrument	Cross-sectional	IV	- SLN Special Forces and regular forces deployed in combat areas	- 259 Special Forces - 412 regular navy personnel	- There was significant association between current smoking and combat experiences - Current smoking was strongly associated with current alcohol use - Prevalence of current smoking was less among military personnel than in the general population. - Prevalence of smoking was significantly higher among Special Forces personnel.

75 Harte CB,	Prospective examination of cigarette smoking among Iraq-deployed and nondeployed soldiers: prevalence and predictive characteristics	2014	USA	- Smoking Characteristics, Alcohol Use, Sociodemographic , Military Characteristics, Deployment-Related Stressful Experiences, Nondeployment-Related Stressful Experiences, Traumatic Stress	Prospective	II	- 1082 US Army soldiers serving between April 2003 and September 2006	- n total= 1082 - 773 Iraq-deployed - 309 non deployed	- Approximately 48 % of participants smoked at both time points, with 6 % initiating smoking and 6 % quitting - Smoking initiation was associated with warzone stress exposure; - female gender and high military unit support predicted cessation - Military rank and alcohol use were associated with both smoking initiation and cessation
86 Allem JP	South Korean Military Service Promotes Smoking: A Quasi-Experimental Design	2012	USA	- Telephone interview questionnaire regarding smoking status and behaviour before, during and after military service	Observational study. Quasi-Experimental Design	IV	- Data were drawn from a population-based probability telephone sample of Korean adults in California	- n total= 475 - 319 veterans - 156 civilians	- Military service is strongly associated with smoking
Respiratory health outcomes									
Author	Title	Year	Country	Measurement	Design	Level of evidence	Population	Sample size	Key Findings
4 Hyams CK	War Syndromes and Their Evaluation: From the U.S. Civil War to the Persian Gulf War	1996	USA	NA	Literature review article	NA	NA	NA	- Poorly understood war syndromes have been associated with armed conflicts (Fatigue, shortness of breath, headache, sleep disturbance, forgetfulness and impaired concentration) - Many types of illness were found among evaluated veterans, including well-defined medical and psychiatric conditions, acute combat stress reaction, PTSD, possibly the chronic fatigue syndrome

5 Rose C	Overview and Recommendations for Medical Screening and Diagnostic Evaluation for Postdeployment Lung Disease in Returning US Warfighters	2012	USA	NA	Literature review and Recommendations	NA	NA	NA	- The Working Group recommended: (1) standardised approaches to pre- and post-deployment medical surveillance (2) criteria for medical referral and diagnosis (3) case definitions for major deployment- related lung diseases
6 Smith B	Newly Reported Respiratory Symptoms and Conditions Among Military Personnel Deployed to Iraq and Afghanistan: A Prospective Population-based Study	2009	USA	- Health survey questionnaire at baseline and follow-up	Retrospective cohort	III-2	- Millennium Cohort Study participants	- 55 021	-New-onset respiratory symptoms higher in deployers (14% vs. 10%), rates of obstructive disease similar at 1% - Deployment length was linearly associated with increased symptom reporting in Army personnel - Elevated odds of symptoms were associated with land-based deployment as compared with sea-based deployment
7 Korzeniewsk	Prevalence of Acute Respiratory Tract Diseases Among Soldiers Deployed for Military Operations in Iraq and Afghanistan	2013	Poland	- Medical record review	Retrospective cohort	III-2	- Polish Military Contingents relocated to Iraq and Afghanistan	- 6 071	- Respiratory tract diseases were the most common health problem treated on an outpatient basis, with a prevalence ranging from 46 to 63 cases per 100 persons - The prevalence of respiratory diseases was closely related to the environmental factors, extreme temperature changes, unsatisfactory sanitary conditions
13 Morris MJ	Study of Active Duty Military for Pulmonary Disease Related to Environmental Deployment Exposures (STAMPEDE)	2014	USA	- Pulmonary function testing, cardiopulmonary exercise testing, methacholine challenge test, bronchoalveolar lavage, impulse oscillometry system testing and high resolution computed tomography imaging	Descriptive case series	IV	- Returning US military personnel	- n total=50 - 40male - 10 female	- 42% had non-diagnostic evaluation - 20% had airway hyper-reactivity - 66% had mental health and sleep disorders

14 Flierl MA	The role of C5a in the innate immune response after experimental blunt chest trauma	2008	Germany	- C5a ,Neutrophil, Factor H, Complements, Cytokines, chemokines	Clinical/ Observational study using animal model	III-3	- Wistar Rats	- 4-8 for each experimental condition	- Blunt chest trauma leads to systemic activation of complement and robust C5a generation, which causes perturbations in defensive functions of neutrophils - C5a might represent a potential target for therapeutic immunomodulation to prevent immune dysfunctions post-trauma
15 King MS	Constrictive Bronchiolitis in Soldiers Returning from Iraq and Afghanistan	2011	UK	- Cardiopulmonary exercise, pathology testing, pulmonary gas exchange and minute ventilation, high-resolution computed tomography (CT)	Descriptive case series	III-3	- US soldiers from Kentucky, with inhalational exposures during service in Iraq and Afghanistan	- 49	- 38/49 soldiers received diagnosis of constrictive bronchiolitis, an otherwise rare illness, which was possibly associated with inhalational exposure
16 Szema AM	New-onset asthma among soldiers serving in Iraq and Afghanistan	2010	USA	- Participants identified through existing database and compared asthma proportions of Iraq/Afghanistan War veterans with veterans deployed stateside - Data source: CD-9 codes 493.00–493.92c	Retrospective	III-2	- All US soldiers deployed and discharged from military service during 2004 -2007 - Soldiers who attended the DVA OEF Clinic	- 920 deployed, - 5 335 state side-stationed troops (not deployed)	- New-onset asthma diagnoses are more common among US veterans returning from Iraq and Afghanistan compared with stateside-stationed troops - Deployment to Iraq and Afghanistan is associated with new-onset asthma
19 Morris MJ	Airway Hyperreactivity in Asymptomatic Military Personnel	2007	USA	- Baseline spirometry examination	Prospective	III-1	- Healthy, asymptomatic, US military personnel with no previous history of asthma and <1 year on active duty status	- 222	- Asymptomatic airway obstruction has a prevalence of 14% in young military personnel - A significant percentage of individuals also have evidence of worsening obstruction during exercise - Screening spirometry may identify early reactive airway disease in asymptomatic individuals
21 Falvo MJ	Airborne Hazards Exposure and Respiratory Health of Iraq and Afghanistan Veterans	2015	USA	NA	Epidemiologic review	II	NA	NA	- Published data based on case reports and retrospective cohort studies suggest a higher prevalence of respiratory symptoms and respiratory illness consistent with airway obstruction

26 Roop SA	The Prevalence and Impact of Respiratory Symptoms in Asthmatics and Nonasthmatics during Deployment	2007	USA	- Health survey questionnaire	Cross-sectional	IV	- Non-asthmatics, and asthmatics active duty soldiers and Department of Defense contractors returning from OEF	- 1 073 non-asthmatics - 58 asthmatics	- Asthmatics with good baseline symptom control are similar to non-asthmatics in their risk of developing worsening respiratory symptoms or functional limitations during deployment - Similar increase in respiratory symptoms during deployment (10% vs. 13%); more prevalent in asthmatics
28 Pazzaglia LTG	Recent trends of pneumonia morbidity in US Naval personnel	1983	USA	- Medical record data	Retrospective	III-3	- Active duty Naval personnel admitted for pneumonia by primary diagnosis	- 29 281	- Respiratory disease is responsible for 25%–30% of infectious disease–related hospital admissions, with pneumonia cited as the leading medical cause of lost workdays
30 Soltis BW	Self-Reported Incidence and Morbidity of Acute Respiratory Illness among Deployed U.S. Military in Iraq and Afghanistan	2009	USA	- Health survey questionnaire during deployment	Cross-sectional	IV	- US troops deployed to Iraq, Afghanistan and the surrounding region	- 15 463	- 39.5% had acute respiratory illness, of these, 18.5% sought medical care and 33.8% reported having decreased job performance because of acute respiratory illness
31 Sanders JW	Impact of illness and non-combat injury during Operation Iraqi Freedom and Enduring Freedom(Afghanistan)	2005	USA	- Health survey questionnaire on return from deployment	Cross-sectional study	IV	- US Military personnel who were deployed to Iraq or Afghanistan in 2003-2004	- 15 459	- 69.1% had acute respiratory illness during deployment - More than two-third had at least one respiratory illness and 17% of these individuals sought medical care - 2% have been diagnosed with mild pneumonia - 47% either began smoking or restarted smoking during deployment
37 Shorr AF	Acute Eosinophilic Pneumonia Among US Military Personnel Deployed in or Near Iraq	2004	USA	- Morbidity, mortality related to AEP	Descriptive case Series	IV	- US military personnel deployed in or near Iraq	- 18	- AEP occurred at an increased rate among this deployed military population and resulted in 2 deaths - With 78% recently beginning to smoke during deployment
39 Abraham JH	Does Deployment to Iraq and Afghanistan Affect Respiratory Health of US Military Personnel?	2012	USA	- Medical record review - ICD-9 codes 490–496	Nested case-control	III-3	- US military personnel with post-deployment medical records	- 532 cases, - 2 128 matched controls	- There was an increase in post-deployment respiratory symptoms and medical encounters for obstructive pulmonary diseases

40 Barth SK	Prevalence of Respiratory Diseases Among Veterans of Operation Enduring Freedom and Operation Iraqi Freedom: Results From the National Health Study for a New Generation of U.S. Veterans	2014	USA	- Health survey questionnaire (National Health Survey for a New Generation of U.S. Veterans)	Retrospective cohort	IV	- US veterans	- 20 563	- Deployed veterans are at increased risk for sinusitis compared to nondeployed. (odds ratio = 1.3) There was no significant difference in asthma or bronchitis risk between deployed and nondeployed veterans
50 Morris MJ	Vocal Cord Dysfunction Related to Combat Deployment	2013	USA	- Medical record review, laryngoscopy, spirometry and methacholine challenge test	Retrospective review/ Descriptive case series	III-2	- US military personnel (OIF,OEF) evaluated at Landstuhl Regional Medical Center with a new VCD diagnosis post-deployment	- 48	- 48% had a truncated flow-volume loop - 83% had a negative methacholine challenge test - 3 of 48 had abnormal spirometry test results
51 Rose C	Military Service and Lung Disease	2012	USA	NA	Literature review	NA	NA	NA	- Respiratory illnesses affect mission readiness, burden active duty military and veterans' health care systems, and may lead to significant morbidity and mortality
65 Gan Q	Association between chronic obstructive pulmonary disease and systemic inflammation: a systematic review and a meta-analysis	2004	Canada	NA	Systematic review	II	NA	NA	- Reduced lung function is associated with increased levels of systemic inflammatory markers, which may have important pathophysiological and therapeutic implications for subjects with stable COPD.
80 Krefft SD	Emerging spectrum of deployment-related respiratory diseases	2015	USA	NA	Literature review	NA	NA	NA	- Investigators from Vanderbilt University, Nashville, TN, found constrictive bronchiolitis on 38 surgical lung biopsies in a case series of army deployers with unexplained chest symptoms - In a group of 50 consecutive deployed patients evaluated at San Antonio Military Medical Center, 36% were found to have airway hyperreactivity, whereas 42% were undiagnosed

81 Szema AM	Respiratory Symptoms Necessitating Spirometry Among Soldiers With Iraq/ Afghanistan War Lung Injury	2011	USA	- Medical record review(data included age, gender, smoking history, deployment location, discharge date, whether they received spirometry, branch of service, diagnoses of TBI and PTSD	Retrospective cohort	III-2	- Compared Iraq/ Afghanistan war veterans to veterans deployed stateside (all soldiers deployed and discharged from military service during March 1, 2004, to December 1, 2010)	- 1816 deployed, - 5 335 non deployed	- New onset Iraq/Afghanistan war lung injury is common and rates of symptoms leading to a diagnosis requiring spirometry are high - Symptomatic soldiers requiring spirometry were more frequent in the Iraq/ Afghanistan group compared with the elsewhere group, with rates of 14.5% and 1.8%, respectively
83 Panos RJ	Patient Reported Determinants of Health: A Qualitative Analysis of Veterans with Chronic Obstructive Pulmonary Disease	2013	USA	- Transcripts demonstrated five major themes: (1) Physical and Functional Limitations; (2) Restricted Social Interactions/ Altered Social Networks; (3) Emotional Effects; (4) Limitations in the Understanding of COPD; and (5) Complex Healthcare Interactions	Qualitative study focus group	IV	- Veterans with COPD and high utilisation of VHA healthcare	- 42	- COPD causes pervasive and extensive effects on all aspects of patients' lives that have significant consequences for their care and management.
84 Korzeniewski K	Respiratory tract infections in the military environment	2015	Poland	NA	Literature review	NA	NA	NA	- ~40–70% of all soldiers participating in recent military operations in Iraq and Afghanistan report to medical treatment facilities due to upper respiratory tract infections - Respiratory health hazards: extreme air temperatures, desert dust, emissions from burn pits, industrial pollutants and airborne contaminants originating from degraded soil