

Centre for Military and Veterans' Health

# The Middle East Area of Operations (MEAO)

## Health Study:

### *Prospective Study Summary Report*

14 December 2012



THE UNIVERSITY  
OF ADELAIDE  
AUSTRALIA



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OF QUEENSLAND  
AUSTRALIA



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Membership of the **Investigators' Committee** changed over the course of the study.

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- Professor Alexander McFarlane AO, CMVH University of Adelaide (First Chief Investigator from 2007 to March 2011)
- Professor Malcolm Sim, Monash University (resigned April 2011)
- Associate Professor Susan Treloar, CMVH, The University of Queensland
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- COL Stephanie Hodson, Director of Mental Health, Department of Defence
- Professor Philip Ryan, University of Adelaide (from March 2011, previously Associate Investigator)
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# Executive Summary

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## Introduction

1. Middle East Area of Operations (MEAO) Prospective Study is the first study to consider the health of deployed Australian military personnel from a longitudinal perspective.
2. Australia has now been at war in Afghanistan and/or Iraq for over a decade and more than 25,000 Australian troops have been deployed, many of whom have been assigned to combat roles.
3. There is now a substantial body of research which demonstrates that repeated exposure to physical and mental trauma over a prolonged period increases the risk of psychological morbidity and related physical symptoms.
4. A number of factors have limited the potential for other studies to investigate the health outcomes associated with the types of traumas these troops may experience, including:
  - the collection of exposure and health data many years after deployment;
  - research that is undertaken in an environment of mistrust and intense media interest;
  - poor recruitment rates for comparison groups; and
  - the lack of baseline data from which to assess the extent of any changes to health outcomes as well as prior exposures.
5. The prospective design employed by the MEAO Prospective Study overcomes many of the challenges faced by other health studies conducted by Australia and its coalition partners, including the:
  - ability to control for exposures and risk factors that exist prior to 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.

## Methodology and Response Rates

6. All ADF members who deployed to the MEAO after June 2010 and returned from deployment by June 2012 were eligible to participate in the self-report questionnaire component.
7. In addition, objective measures of physical and psychological health were collected through physical tests and neurocognitive assessments in a sub sample of personnel primarily involved in combat roles.

8. Detailed protocols and quality management plans ensured that the study was conducted in accordance with accepted best practice standards for research, including the processing of each pathology sample in the same laboratory at both pre- and post-deployment.
9. Of the total population (n=3074), 60.9% responded to the pre-deployment self-report questionnaire and 70.8% of those completed a further self report-questionnaire at post-deployment.
10. A total of 655 also participated in a physical test at pre-deployment, and 60.9% of those respondents undertook the same physical test at post-deployment.
11. A total of 278 also participated in a neurocognitive assessment at pre-deployment, and 61.2% of those respondents undertook the same neurocognitive assessment at post-deployment.

## Findings

12. The majority of participants were psychologically, physically and socially healthy both before and after deployment.
13. A number of clinically significant findings were identified at both pre- and post-deployment. Specifically:
  - 2.5% of the participants at pre-deployment and 4.8% of the participants at post-deployment reported symptoms which were consistent with psychological distress,
  - 0.1% of the participants at pre-deployment and 1.9% of the participants at post-deployment reported symptoms which were consistent with post traumatic stress disorder (PTSD),
  - 1.0% of the participants at pre-deployment and 2.5% of the participants at post-deployment reported symptoms which were consistent with an alcohol disorder,
  - 0.7% of the participants at pre-deployment and 1.6% of the participants at post-deployment reported suicidal ideation,
  - 11.1% of the participants at pre-deployment and 14.9% of the participants at post deployment were obese based on the waist to hip ratio,
  - 1.1% of the participants at pre-deployment and 1.6% of the participants at post-deployment met the criteria for hypertension; and
  - 4% of the participants at pre-deployment and 4.5% of the participants at post-deployment met the internationally recognised criteria for airway obstruction.
14. A number of statistically significant changes were found for psychological, and to a lesser extent, physical and social health outcomes, between pre- and post-deployment.

15. These sub-clinical changes (which were statistically but not clinically significant) between pre- and post-deployment, were primarily related to:
  - being in a combat role or operating outside the main support base in Afghanistan,
  - reporting higher numbers of traumatic deployment experiences related to the most recent deployment,
  - reporting specific types of traumatic deployment experiences on the most recent deployment, including those associated with being in 'a vulnerable situation or in fear of a particular event'; and
  - time away on the most recent deployment.
16. Apart from lifetime mild traumatic brain injuries (mTBIs) reported at pre-deployment and perceived problems with children on the most recent deployment, prior deployment experiences did not predict the magnitude of change to psychological, physical and social health.
17. An association was found between prior deployment experiences and changes to cognitive functioning. There was also evidence to suggest that these changes may remain stable over subsequent deployments.

### **Limitations**

18. The scope of this report did not allow for the in-depth analyses warranted by such an extensive and valuable dataset.
19. While physical testing and neurocognitive assessments produced objective measures of health, the self report questionnaire data presented in this report were based on subjective assessments made by the participants.
20. Structured diagnostic interviews were not used to more accurately identify psychological disorders.
21. The findings presented in this report 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.
22. The purpose of this report was not to identify differences in prevalence of various conditions in sub-groups. In addition, the small numbers in some of the sub-groups may mean that there was not sufficient power to detect clinically significant differences.

### **Conclusion**

23. Combat roles or operating outside the main support base were found to be associated with small increases in psychological symptoms at post-deployment compared to pre-deployment in the same individuals.

24. Prior trauma exposure and other lifetime experiences were significantly associated with psychological co-morbidity at post-deployment, particularly for those participants who reported levels of psychological distress, PTSD symptoms and alcohol misuse above the Australian Defence Force (ADF) cut-offs at post-deployment.
25. The number of previous deployments and time away on previous deployments were significantly associated with changes in cognitive functioning, and continuing evidence of increased arousal and decreased efficiency in the nervous system.
26. Finally, this Prospective Study along with the other MEAO Health Studies, provides the baseline for a coherent program for the long-term surveillance of the health of deployed ADF personnel.

## Introduction

Australia has now been at war in Afghanistan for over a decade, twice the duration of World War II, and over 24,000 Australian troops have now deployed to the MEAO. Many have deployed several times. While to date no estimate has been made of the potential health costs in Australia, the potential health costs of the United States of America engagements in Iraq and Afghanistan could exceed \$900 billion [1 pp 214-221].

War results in adverse health outcomes above and beyond acute combat related injuries [2]. Butler's [3] history of the Australian Imperial Force Medical Corp in World War I reported an increase in what was referred to as "the burnt out soldier effect". Similar impacts were observed in the Canadian World War I forces [2]. A longitudinal study of Harvard sophomores recruited in 1938 and followed up annually [4], also demonstrated an increase in disease and premature mortality in the group who had high combat exposure in World War II.

More recently, a range of disorders not associated with battle injuries have been linked to combat. Psychiatric disorders including depression, PTSD and anxiety, as well as somatic symptoms such as those related to chronic fatigue syndrome, fibromyalgia and chronic pain, may be related to combat stress. However, it is also possible that these symptoms relate to other unanticipated environmental exposures; thus monitoring is necessary to identify the health consequences associated with deployment.

A number of health studies involving deployed military populations have already been conducted by Australia and its coalition partners. However, many of these previous studies have been prompted by ad hoc reports of somatically focused syndromes such as Gulf War Syndrome, or by concern about specific chemical and other hazards, such as Agent Orange in Vietnam [5]. In addition, these studies often had to overcome limitations including the need to account for lag times between the deployment exposures and data collection, the bias which may be introduced with self-report data, and a narrow range of health outcomes which were considered.

The MEAO Prospective Study was designed to implement the lessons learnt from other studies through the use of a longitudinal design. For example, to ensure that

any changes in health outcomes could be directly attributable to the deployment experience rather than prior life exposures, data were collected immediately prior to (pre-deployment) and then again approximately four months after (post-deployment) personnel returned from deployment. In addition, rather than focusing on a small number of specific conditions, the MEAO Prospective Study measured a diverse range of health issues relevant to deployed military populations. The MEAO Prospective Study was also specifically designed to collect objective measures of health through physical tests and neurocognitive assessments conducted at both pre- and post-deployment, rather than relying solely on self-reported data. This design ensured that a wide range of objective markers as well as subjective measures of psychological, physical and social impacts, which may be related to deployment were captured.

## Methodology

ADF members who deployed to the MEAO after June 2010 and returned from that deployment by June 2012 were eligible to participate in the MEAO Prospective Study (n = 3074). In addition, a sub-sample of primarily combat personnel was invited to provide objective health measures – namely physical tests and/or neurocognitive assessments.

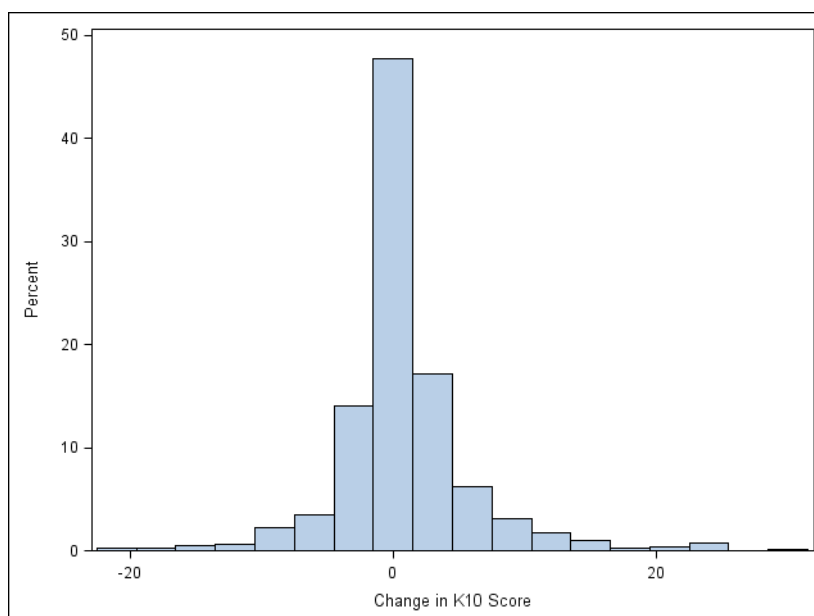
All data were collected at two time points. In the first instance participants provided data not more than four months prior to their deployment (pre-deployment) and then again, on average 4.2 months after they returned home (post-deployment). A major strength of this methodology was that it allowed for individuals to act as their own control, overcoming the need to identify a comparison group.

Of the total population (n = 3074), 60.9% responded to the pre-deployment self-report questionnaire and 70.8% of those also completed a further self report-questionnaire at post-deployment. A total of 655 responders also participated in a physical test at pre-deployment, and 60.9% of those undertook the same physical test at post-deployment. In addition, 278 responders participated in a neurocognitive assessment at pre-deployment, and 61.2% of those undertook the same neurocognitive assessment at post-deployment.

## Findings

While there were changes between pre- and post-deployment for the health outcomes considered in this report, the majority of individuals who responded to the MEAO Prospective Study were psychologically, physically and socially healthy before and after deployment. For example, three quarters of respondents had low psychological distress and over 90% met the criteria for low depressive symptoms and minimal PTSD symptoms, at pre-deployment. In some cases the health of participants improved between pre- and post-deployment. For example, 2.5% of respondents who reported symptoms consistent with high psychological distress at pre-, were considered to be within the low psychological distress band at post-deployment (Figure i).





**Figure i: Distribution of change in mean K10 scores between pre- and post-deployment.**

A similar pattern of little morbidity in the majority of participants was also found for the physical health measures. For example, while 26.9% of participants reported a lifetime mTBI, only 9.3% reported a new mTBI as a result of their most recent deployment. In addition, the majority fell within the normal range for cardiovascular fitness (82.6%) and over 83% of participants had a normal lung function based on their age and height at both pre- and post-deployment. The study also showed that leishmaniasis [6] and hepatitis C [7], both of which are prevalent in military personnel deployed by Australia’s coalition partners, were not found in any of the respondents in this study at either pre- or post-deployment. In addition, in contrast to other military studies [8-10], there was no evidence of significant changes to the skin conditions of these Australian respondents following the most recent deployment. Together, these findings suggested that the protective health measures employed by Defence have been effective in a number of domains.

It was expected that the MEAO Prospective Study sample would be particularly healthy for a number of reasons. First, initial recruitment selection already ensures a relatively health workforce in comparison to the general Australian population. However, the additional health checks that are required prior to deployment ensure that this sample would comprise of some of the fittest members of the ADF. Second, post-deployment data collection occurred on average four months after returning from deployment and, therefore, some deployment related disorders may already have been effectively treated while others may not yet be manifest.

### **Clinically Significant Findings**

There were clinically significant findings (Table i) at both pre- and post-deployment found.

**Table i: Percentage of clinically significant findings identified at pre- and post-deployment**

#### **Psychological Distress**

2.5% of the participants at pre-deployment and 4.8% of the participants at post-deployment were above the epidemiological cut-off [11] which suggests they would meet the criteria for anxiety or affective disorder.

**PTSD Symptoms**

0.1% of the participants at pre-deployment and 1.9% of the participants at post-deployment were above the epidemiological cut-off [11] which suggests they would meet the criteria for PTSD.

**Alcohol Usage**

1.0% of the participants at pre-deployment and 2.5% of the participants at post-deployment scored above the epidemiological cut-off [11] which suggests they would meet the criteria for an alcohol disorder.

**Suicide Ideation**

0.7% of the participants at pre-deployment and 1.6% of the participants at post-deployment reported suicidal ideation. As a duty of care, these participants were contacted by a research staff member who had successfully completed the Applied Suicide Intervention Skills Training to ensure that they had or were receiving appropriate care.

**Cardiovascular Risk**

1.1% of the participants at pre-deployment and 1.6% of the participants at post-deployment had hypertension.

**Lung Function**

4% of the participants at pre-deployment and 4.5% of participants at post-deployment met the Global Initiative for Chronic Obstructive Lung Disease criteria for airway obstruction. As a duty of care, these participants were notified of the finding and advised to seek further medical advice.

These findings support the need for continued improvements to post-deployment operational screening and the potential need to introduce additional pre-deployment screening in order to better support personnel while on deployment.

In addition, there was also a decrease in sero - prevalence between pre- and post-deployment for IgG titre measures in the Herpes family of viruses. While this finding may indicate immuno-competence, further analyses are required.

**Sub-Clinical Changes**

In addition to these findings of clinical concern, there were also a number of statistically, but not clinically, significant changes between pre- and post-deployment. While these changes are small on average and do not require treatment, they are systematically associated with a number of deployment exposures.

Where change is discussed it reflects the average change in scores on a particular scale. For example, a change of 1.15 means that on average participants increased just over one point on the associated scale between pre- and post-deployment. Where odds ratios (OR) are presented they reflect the likelihood of a particular event or outcome. For example, an OR of 1.93 suggests that on average one group of

participants are almost twice as likely to have a particular outcome, in comparison to another group. Confidence intervals (CI) are also provided to show the range of values within which the true result probably lies.

### **Combat Role or Operating Outside the Main Support Base**

Changes to both psychological and physical health were associated with the role on the most recent deployment. A number of statistically significant differences were found when comparing the health outcomes for participants whose role was inside a main support base or operating outside of Afghanistan, with those participants who operated in a combat role or who were based outside of main support base in Afghanistan (Table ii).

**Table ii: Statistically significant sub-clinical changes to health outcomes associated with roles on most recent deployment.**

#### **Psychological Distress**

The increase in psychological distress scores between pre- and post-deployment was greater for those in a combat role or who operated outside a main support base (change = 1.15, 95% confidence interval (CI) = 0.76 to 1.54) compared to those working outside Afghanistan (change = 0.22, 95% CI -0.03 to 0.77), but not compared to those whose role was inside a main support base (change = 0.48, 95% CI -0.10 to 1.06).

#### **Depressive Symptoms**

A greater proportion of participants in a combat role or who worked outside the main support base had an increase in depressive symptoms between pre and post deployment, compared to those who operated inside of a main support base or outside of Afghanistan (odds ratio (OR) = 1.93, 95% CI 1.04 to 3.60).

#### **PTSD Symptoms**

The increase in PTSD symptom scores between pre- and post-deployment was greater for those in a combat role or who operated outside a main support base (change = 3.82, 95% CI 3.26 to 4.36), than for those whose role was inside a main support base (change = 1.96, 95% CI 1.14 to 2.78) or outside Afghanistan (change = 0.36, 95% CI -0.12 to 1.14).

#### **Alcohol Usage**

The increase in alcohol usage scores between pre- and post-deployment was greater for those in a combat role or who operated outside a main support base (change = 0.55, 95% CI 0.26 to 0.84), than for those whose role was inside a main support base (change = -0.36, 95% CI -0.79 to 0.08) or outside Afghanistan (change = -0.33, 95% CI -0.74 to 0.08).

#### **Somatic Symptoms**

The increase in the number of somatic symptoms between pre- and post-deployment was greater for those in a combat role or who operated outside a main support base (change = 3.67, 95% CI 2.96 to 4.37) compared to those outside Afghanistan (change = 0.73, 95% CI -0.31 to 1.76), but not compared to those whose role was inside a main support base (change = 2.34, 95% CI 1.27 to 3.42).

### **New mTBI**

Compared to those outside Afghanistan respondents who were on a combat role in Afghanistan or who worked outside the main support base were significantly more likely to report a new mTBI at post-deployment, compared to those who were in non-combat roles outside Afghanistan (OR=6.54, 95% CI 2.35, 18.24).

### **Cardiovascular Fitness**

The decrease in cardiovascular fitness scores between pre- and post-deployment was greater for those in a combat role or who operated outside a main support base (change = 18.51, 95% CI 16.72 to 20.31) compared to those outside Afghanistan (change = -0.81, 95% CI -7.85 to 6.23), but not compared to those whose role was inside a main support base (change = 17.54, 95% CI 12.91 to 22.17).

High risk groups such as ADF members who operate in a combat role or who operate outside the main support base during deployment may require more intensive follow-up post-deployment and at point of discharge, as they move into the veteran community.

## **Traumatic Deployment Exposures**

Both the number and types of self-reported traumatic deployment exposures were associated with decreased physical and psychological health between pre- and post-deployment. The number of traumatic deployment exposures on most recent deployment (Low = 0 to 4, Medium = 5 to 16, High = 17 to 35 and Very High = 36 to 104) was significantly associated with changes to both psychological and physical health outcomes (Table iii).

**Table iii: Statistically significant changes to health outcomes associated with the number of traumatic deployment experiences.**

### **Psychological Distress**

The increase in psychological distress scores was significantly different between the four categories of traumatic deployment exposures. This difference was mainly due to the Very High category, which showed the greatest increase in psychological distress between pre- and post-deployment (change = 1.40, 95% CI 0.84 to 1.96).

### **Depressive Symptoms**

Those participants who reported Very High traumatic deployment exposures were more likely to also increase in depressive symptoms between pre- and post-deployment (OR = 2.65, 95% CI 1.40 to 5.02).

### **PTSD Symptoms**

The increase in PTSD symptom scores between pre- and post-deployment was significantly different between the four categories of traumatic deployment exposures. This difference mainly due to the Very High category, which showed the greatest increase in PTSD symptoms between pre- and post-deployment (change = 4.98, 95% CI 4.21 to 5.76).

### **Alcohol Usage**

The increase in alcohol usage scores between pre- and post-deployment was significantly different between the four categories of traumatic deployment exposures. This difference was mainly due to the Very High category, which showed the greatest increase in alcohol usage between pre- and post-deployment (change = 0.36, 95% CI -0.05 to 0.79).

### **Somatic Symptoms**

Compared to participants in the Low category (change = 0.36, 95% CI =0.62 to 1.35), those in the Medium (change = 3.02, 95% CI 1.94 to 4.10), High (change = 3.24, 95% CI 2.21 to 4.26) and Very High (change = 4.02, 95% CI 3.01 to 5.04) categories of traumatic deployment exposures reported significantly more somatic symptoms between pre- and post-deployment.

### **New mTBI**

Those respondents who had High (OR = 6.96, 95% CI 2.19 to 22.09) and Very High (OR = 22.72, 95% CI 7.26 to 71.10) numbers of deployment exposures were significantly more likely to report a new mTBI at post-deployment compared to those who had the lowest number of exposures.

### **Cardiovascular Fitness**

Compared to participants who fell within the Low category for the number of traumatic exposures (change = 5.76, 95% CI = -1.33 to 12.86), those in the Medium (change = 17.30, 95% CI 12.49 to 22.10), High (change = 18.08 95% CI 15.01 to 21.14) and Very High (change = 18.17, 95% CI 15.75 to 20.59) categories had significantly greater decreases in cardiovascular fitness between pre- and post-deployment.

Reports of being in a vulnerable situation or in fear of a particular event, unable to respond to a threatening situation, and witnessing human degradation, were associated with increases in psychological distress, depressive symptoms, PTSD symptoms, alcohol use and somatic symptoms. These exposures were similar to those identified in the 2010 ADF Mental Health Prevalence and Wellbeing Survey [11] as being associated with the greatest risk of PTSD. This finding demonstrates the importance of recording traumatic deployment experiences, as they may be an effective predictor of psychological morbidity. Clinical screening which includes the reporting of traumatic experiences as soon as possible after they occur, rather than at the end of the deployment, should be considered.

### **Longer Deployments**

In general, being away for nine to twelve months and six to seven months (but not necessarily eight months) tended to be associated with greater changes to a number of self-reported health outcomes (Table iv).

**Table iv: Statistically significant changes to health outcomes associated with the length of deployment.**

### **Psychological Distress**

The participants who were deployed for 6 to 7 months or 9 to 12 months were significantly more likely to have increased psychological distress scores, compared to those who were deployed for 5 months or less: 6 to 7 months, OR = 1.94, 95% CI 1.27 to 2.96; and 9 to 12 months, OR 1.92, 95% CI 1.16 to 3.19

### **PTSD Symptoms**

The increase in PTSD symptom scores between pre- and post-deployment was significantly greater on average for those who were away for 6 to 7 months (change = 3.10, 95% CI 2.37 to 3.83) and 9 to 12 months (change = 3.58, 95% CI 2.62 to 4.55) than those who were away on deployment for 5 months or less (change = 1.34, 95% CI 0.62 to 2.05).

### **Alcohol Usage**

The alcohol usage scores for participants who were away on deployment for 8 months significantly increased between pre- and post-deployment (change = 0.62, 95% CI 0.18 to 1.06). In contrast, alcohol usage scores significantly decreased between pre- and post-deployment for those away for 5 months or less (change = -0.47, 95% CI -0.85 to -0.10).

### **Somatic Symptoms**

The increase in the number of symptoms reported between pre- and post-deployment was greater on average for those who had been deployed for 6 to 7 months (change = 3.74, 95% CI 2.81 to 4.67) and 9 to 12 months (change = 3.77, 95% CI 2.56 to 4.99), than for those who had been deployed for 5 months or less (change = 0.96, 95% CI 0.03 to 1.89).

### **Body Mass Index**

While the overall changes to BMI between pre- and post-deployment were small, the change was significantly greater on average for those away for 6 to 7 months (change = 0.75, 95% CI 0.56 to 0.94), 8 months (change = 0.67, 95% CI 0.43 to 0.92) and 9 to 12 months (change = 0.94, 95% CI 0.57 to 1.31), compared to those who were away on deployment for less than or equal to 5 months (change = -0.11, 95% CI -0.36 to 0.13).

### **Blood Pressure**

Participants who had deployed for 6 to 7 months (OR = 0.44, 95% CI 0.22 to 0.88) and 8 months (OR = 0.35, 95% CI 0.19 to 0.66) were significantly less likely to have a decrease in blood pressure compared to participants who had deployed for 5 months or less.

### **Cardiovascular Fitness**

The increase in cardiovascular fitness scores between pre- and post-deployment was significantly greater, on average for those deployed for 9 to 12 months (change = 24.00, 95% CI 19.05 to 28.95), compared to those deployed for 5 months or less (change = 13.67, 95% CI 10.36 to 19.98); with intermediate results for those away for 6 to 7 months (change = 18.08, 95% CI 15.46 to 20.70) or 8 months (change = 16.29, 95% CI 13.06 to 19.53).

### **Respiratory Health**

The increase in forced expiratory volume at one second (FEV1) and FEV1 % predicted scores<sup>1</sup>, suggesting improved respiratory health, between pre- and post-deployment was significantly greater, on average for those who deployed for 9 to 12 months (change = 3.9, 95% CI 1.26 to 6.55). In comparison, there was a significant decrease in FEV1 % predicted scores between pre- and post-deployment: on average for those who deployed for 6 to 7 months (change -2.80, 95% CI -4.42 to -1.17) and 8 months (change = -3.42, 95% CI -5.18 to -1.67). Similar results were found for forced vital capacity (FVC) and FVC % predicted scores.

### **Personal Relationships**

Participants who were away for 9 to 12 months were more likely to report that they or their partner had contemplated divorce or a permanent separation since the beginning of their most recent deployment (OR = 4.39, 95% CI 1.28 to 4.47) compared to those who were away for 5 months or less.

The association between longer duration of most recent deployment and increased psychological and somatic symptom reporting was not always linear. These findings suggested that those participants who were away for eight months were different to the participants who were away for six to seven months and nine to twelve months. Rather than being an effect of time on most recent deployment, it is more probable that these findings are associated with demographic factors and/or deployment experiences. For example, it is possible that these participants were younger and on their first deployment. Another potential explanation is that the participants who deployed for eight months primarily belonged to a unit that functioned differently to other units that were on longer or shorter deployments. To test these hypotheses further investigation is required.

### **Prior Deployment Experiences**

Reporting a lifetime mTBI at pre-deployment and perceived problems with their children on the most recent deployment were the only health outcomes which were associated with any of the prior deployment experiences (number of prior deployments, time away on prior deployments in the past three years and prior combat exposure). Participants who reported previous combat exposure, were more likely to report a lifetime mTBI at pre-deployment (OR 2.03, 95% CI 1.43 to 2.87).

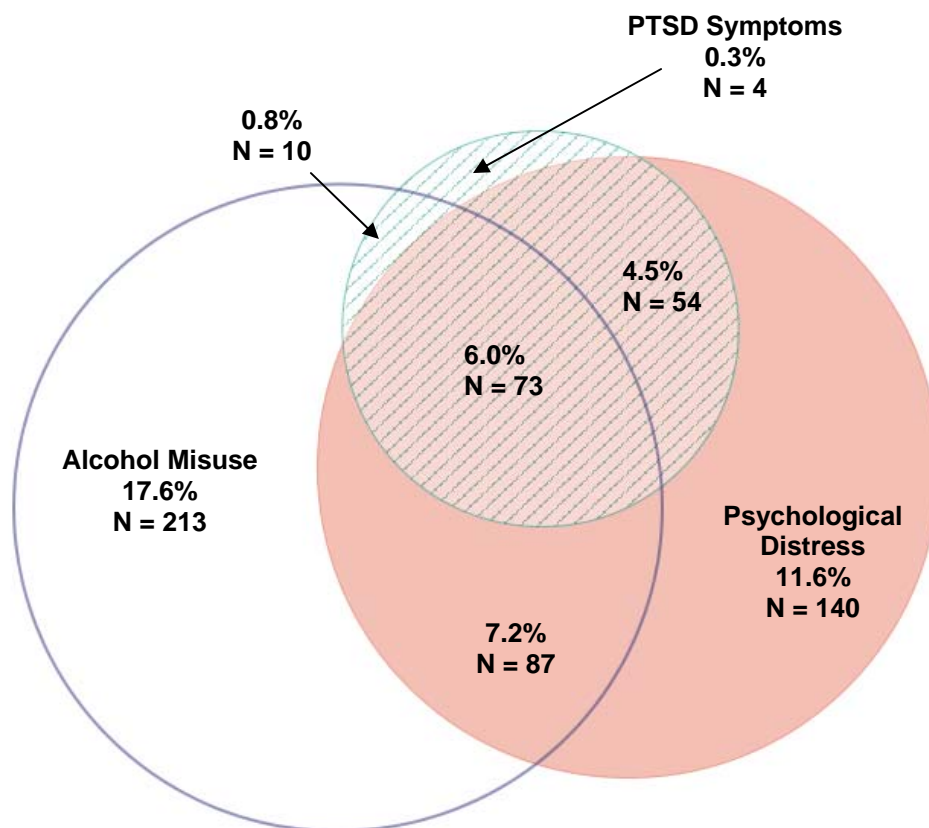
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<sup>1</sup> Percentage predicted presents the result as a percent of the "predicted values" for the participant, given their height, age and sex. Therefore, 95% predicted percentage for FEV1 would equate to a participant having 95% of their expected expiratory volume at one second, given their height, age and sex.

Similarly, compared to participants who had no prior combat exposure, those who had were significantly more likely to perceive problems with their children while on the most recent deployment (OR = 2.11, 95% CI 1.10 to 4.05).

## Psychological Co-morbidity

As well as sub-clinical increases in both physical and psychological health outcomes between pre- and post-deployment, the analyses also identified a group of participants who at post-deployment were at risk of psychological morbidity. In total 214 participants reported symptoms which were above the ADF screening criteria cut-off levels for a number of psychological conditions [12]. Specifically, 73 participants reported symptoms which were above the ADF screening criteria cut-off levels for three psychological conditions (psychological distress, PTSD symptoms and alcohol misuse), while 151 participants reported symptoms above the cut-off criteria for two of these conditions (Figure ii).



**Figure ii: Co-morbidity between psychological distress, PTSD symptoms and alcohol misuse at post-deployment for personnel who provided data both pre- and post-deployment**

In addition, the analyses of this co-morbid group identified a set of associations that may be indicative of the risk factors for high levels of distress (Table v).

**Table v: Summary of associations with co-morbid psychological conditions at post-deployment.**

### Length of Most Recent Deployment

Participants who were deployed for longer times were more likely to have a greater number of co-morbid psychological conditions than those who were away for five months or less: for 6 to 7 months OR = 1.80, 95% CI 1.33 to 2.43; for 8 months OR = 1.26, 95% CI 0.90 to 1.77; and for 9 to 12 months (OR = 1.60, 95% CI 1.12 to 2.28).



### **Role on Most Recent Deployment**

Participants who were in a combat role or who operated outside the main support base had more psychological conditions at post deployment, compared to those who were operated inside a main support base or outside of Afghanistan (OR = 1.79, 95% CI 1.15 to 2.78).

### **Traumatic Deployment Exposures**

Participants who reported a Very High (36 to 104) number of traumatic deployment exposures on their most recent deployment were more than twice as likely to have two or more co-morbid conditions compared to those who reported a Low number (0 to 4).

In addition, people with two or more co-morbid psychological conditions were significantly more likely to report each of the traumatic deployment exposure types, such as 'being in danger of being killed', 'handling a dead body' and/or 'hearing of a close friend or co-worker who had been injured or killed', in comparison to those with none or only one psychological condition at post-deployment.

### **Number of Prior Life Traumas**

Participants with more prior life traumas at pre-deployment, were likely to have more co-morbid psychological conditions at post deployment, compared to those who had no or less than 3 prior lifetime traumas: for 5 or more prior lifetime traumas, OR = 2.28, 95% CI 1.63 to 3.19; for 3 or 4, OR = 1.75, 95% CI 1.26 to 2.42.

### **Tobacco Usage**

Participants who began or restarted smoking and those who smoked more than usual while on deployment, were likely to have more co-morbid psychological conditions at post-deployment, compared to participants who did not smoke while on deployment; began or restarted, OR = 2.22, 95% CI 1.36 to 3.60; smoked more than usual OR = 2.03, 95% CI 1.33 to 3.10.

### **Somatic Symptom Reporting**

With each increase in number of psychological conditions at post-deployment, there was a corresponding increase in the number of somatic symptoms reported at post-deployment. The greatest number of symptoms was observed for those with three psychological co-morbidities.

### **New mTBIs**

Participants who reported a new mTBI at post deployment were more likely to report multiple psychological conditions than participants without a new mTBI: OR = 3.25, 95% CI 1.89 to 5.60 for two conditions and OR = 5.92, 95% CI 3.14 to 11.16 for three conditions, relative to those who had no psychological conditions.

### **Personal Relationships**

Participants who reported a decrease in their relationship satisfaction between pre- and post-deployment were more likely to report multiple psychological conditions: OR = 2.45, 95% CI 1.10 to 5.46 for two conditions and OR = 4.95, 95% CI 2.14 to 11.49 for three conditions compared to those with no psychological conditions.

Likewise, participants who reported that they or their partner had considered divorce or permanent separation since the beginning of the most recent deployment were more likely to report multiple psychological conditions: OR = 3.85, 95% CI 2.19 to 6.75 for two conditions and OR = 8.19, 95% CI 4.24 to 15.83 for three conditions, compared to those with no psychological conditions.

Conversely, participants who perceived that they received sufficient support while on deployment from their family and/or partner were less likely to report multiple psychological conditions: OR = 0.43, 95% CI 0.21 to 0.91 for two conditions and OR = 0.33, 95% CI 0.13 to 0.82 for three conditions in comparison to those with no psychological conditions at post-deployment.

### **Relationships with Children**

Participants who perceived that their military career had negatively impacted their children were more likely to report multiple psychological conditions: OR 3.31, 95% CI 1.81 to 6.06 for two conditions and OR = 6.75, 95% CI 2.50 to 18.24 for three conditions in comparison to those with no psychological co-morbidities.

These personnel with psychological co-morbidity may require particular attention. Methods of better detecting, diagnosing and following up this group need to be considered. In particular, the effectiveness of the post-deployment mental health screens in detecting multiple psychological co-morbidities requires evaluation.

## **Neurocognitive Assessments**

In contrast to the findings from the self-report data on psychological conditions, neurocognitive assessments conducted in this study identified a prior deployment effect. As in another recently published study [13], there was evidence of increased arousal and decreased efficiency of working memory in participants who had reported prior deployment experiences (Table vi).

**Table vi: Summary of neurocognitive findings.**

### **Quantitative Electroencephalography (qEEG)**

qEEG measurements with participants' eyes open, which test the ability to attend to environmental signals, showed that prior combat exposure was associated with increased alpha-2 rhythm in the centro-parietal regions, indicating relative inability to adjust to environmental inputs. This finding may suggest disruption of the working memory function associated with aspects of deployment. Increased alpha-2 rhythm in the frontal regions is thought to be associated with significantly increased arousal, and is a potential marker for future morbidity. These changes, once they occurred, appeared to be stable between deployments, rather than returning to a base level post-deployment.

### **Working Memory**

Related changes in neurocognitive functioning associated with prior deployments were also identified from an event related potential task that measures working memory. The results indicated, for example, that both the effort required and the time taken to update working memory were significantly negatively associated with the participants' prior combat experience and number of previous deployments. In addition, the length of the most recent deployment and the number of traumatic exposures reported for the most recent deployment had a further negative association on working memory function.

Despite 13.8% of the entire pre- and post-deployment sample having reported prior combat exposure and over half of the sample (57.7%) having been on at least one previous deployment, analyses of the self-report data did not show any association between prior deployment experiences and psychological symptoms. It is possible that participants concerned about their ability to deploy, did not accurately report their symptoms. Therefore, the introduction of objective measures such as the neurocognitive assessments used in this study should be assessed for their capacity to better detect changes to cognitive and psychological functioning [14, 15].

Additionally, there were a number of other neurocognitive measurements (Emotional Processing, Response Inhibition and Startle) which were collected but could not be analysed within the timeframe. These measures are relevant to describing operational capacity and PTSD symptoms such as an exaggerated startle response.

One potential use for these neurocognitive assessments is to measure any residual cognitive effects of mTBIs. Previous research has shown that EEG is able to detect diminished functioning in participants who have incurred an mTBI [16], and to discriminate between mild and severe traumatic brain injuries [17]. As 9% of participants reported they had incurred a new mTBI since the beginning of their most recent deployment, the development of an accurate screening tool to detect any residual effects would be of considerable benefit. Such a tool could measure cognitive changes associated with mTBI and separate these from related psychological disorders such as PTSD.

### **Allostatic Load**

The initial analysis of allostatic load, another potential objective measure of future risk for morbidity and/or mortality, was not conclusive. However, there are a number of possible reasons for this. First, poor response to collecting the saliva samples for adrenaline, noradrenaline and cortisol meant that these measures, which have consistently been included in other studies of allostatic load, were not available. Second, a simple cumulative model was used to calculate an allostatic load score, and it may be necessary to consider a more sophisticated method such as latent class analysis to identify any association with future risk among the relatively healthy participants in this study. However, this type of analysis was well beyond the scope of this report.

## Study Limitations

One of the major limitations to be acknowledged is that the scope of this report did not allow for the in-depth analyses warranted by such an extensive and valuable database. Caution should therefore be applied to the present findings which all require further analyses. Furthermore, these data were collected for the fundamental purpose of establishing an accurate measure of deployment related exposures as a baseline of health indices. Insufficient time may have elapsed for many of the disorders of interest to have emerged since returning from deployment. Hence further follow-up of this cohort is critical in order for this invaluable database to be properly utilised.

It is also important to note that the purpose of this study was not to provide prevalence estimates of psychological, physical or social health morbidity within the deploying population. In particular, all eligible deploying personnel were not available to participate at either pre- and/or post-deployment. In addition, some participants did not complete all parts of the data collection and therefore, sample sizes were further reduced for the analyses of some health outcomes.

It should also be acknowledged that the reported psychological symptoms were all based on self-report data. In order to more accurately identify psychological disorders the Composite International Diagnostic Interview (CIDI) or a similar structured diagnostic interview is necessary.

## Conclusion

The initial analysis of the extensive MEAO Prospective Study database found evidence for the following.

1. Combat exposure or operating outside the main support base was associated on average with increases in psychological symptoms at post-deployment compared to pre-deployment in the same individuals.
2. Prior trauma exposure and other lifetime experiences were significantly associated with psychological co-morbidity at post-deployment. This finding supports the hypothesis that an increasing burden of risk is acquired progressively across deployments.
3. The number of previous deployments and time away on previous deployments were significantly associated with changes in cognitive functioning, and evidence of increased arousal and decreased working memory efficiency.
4. Despite the environments in which these troops were deployed, in general there were low rates of physical illness and disease evident at the post-deployment. Indeed, the health of a small number of participants improved between pre- and post-deployment.

Finally, the MEAO Health Studies, including the MEAO Prospective Study, provide the baseline for a coherent program for the long-term surveillance of the health of deployed ADF personnel.

## Need for Further Analyses

The MEAO Prospective Study has collected an extensive dataset on the health of deployed personnel. To do justice to the national and international significance of this dataset further analyses are required.

First, it is important to undertake the analyses of the following data which due to time constraints could not be included in this report:

- Neurocognitive assessments - Emotional processing
- Neurocognitive assessments - Startle
- Neurocognitive assessments - Response inhibition

Second, also due to time constraints an investigation of the following conditions at pre- and/or post-deployment is still required.

- Skin conditions
- Infectious diseases
- Abnormal biochemistry results

Third, while more analyses of the associations between changes to health outcomes and deployment exposures were presented in the chapters of this report, more detailed analyses of the confounders, effect modifiers, moderators and mediators that may impact on these associations are still required.

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