

RESEARCH REPORT

Gambling problems among Australian military personnel after deployment: analyses of the Middle East Area of Operations (MEAO) Prospective Health Study

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Conflict of interest declaration

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Dr Cowlshaw, S,^{1,2} Dr Metcalf, O,¹ Dr Little, J,¹ Dr Sbisa, A,¹ Dr Deans, C,¹ Prof. O'Donnell, M,¹ Ms Sadler, N,¹ Dr Van Hooff, M,³ Dr Lawrence-Wood, E,³ Ms Crozier, T,¹ Prof. Battersby, M,⁴ Prof. McFarlane, A,³ and Prof. Forbes, D,¹ 2020, *Gambling problems among Australian military personnel after deployment: analyses of the Middle East Area of Operations (MEAO) Prospective Health Study*, Victorian Responsible Gambling Foundation, Melbourne.

Enquiries

Rosa Billi +61 3 9452 2625

rosa.billi@responsiblegambling.vic.gov.au

Victorian Responsible Gambling Foundation

Level 6, 14–20 Blackwood Street

North Melbourne

Victoria 3051

PO Box 2156

Royal Melbourne Hospital

Victoria 3050

Telephone: +61 3 9452 2600

Facsimile: +61 3 9452 2660

ABN: 72 253 301 291

¹ Phoenix Australia – Centre for Posttraumatic Mental Health, Department of Psychiatry, University of Melbourne

² Population Health Sciences, Bristol Medical School, University of Bristol, United Kingdom

³ Centre for Traumatic Stress Studies, University of Adelaide, Adelaide, Australia

⁴ College of Medicine and Public Health, Flinders University, Australia

Our vision: A Victoria free from gambling-related harm



Gambling problems among Australian military personnel after deployment: analyses of the Middle East Area of Operations (MEAO) Prospective Health Study

Dr Sean Cowlshaw,^{1,2} Dr Olivia Metcalf,¹ Dr Jonathon Little,¹ Dr Alyssa Sbisa,¹ Dr Carolyn Deans,¹ Professor Meaghan O'Donnell,¹ Ms Nicole Sadler,¹ Dr Miranda Van Hooff,³ Dr Ellie Lawrence-Wood,³ Ms Tilly Crozier,¹ Professor Malcolm Battersby,⁴ Professor Alexander McFarlane³ and Professor David Forbes¹.

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1. Phoenix Australia – Centre for Posttraumatic Mental Health, Department of Psychiatry, University of Melbourne
2. Population Health Sciences, Bristol Medical School, University of Bristol, United Kingdom
3. Centre for Traumatic Stress Studies, University of Adelaide, Adelaide, Australia
4. College of Medicine and Public Health, Flinders University, Australia



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Terminology

Term	Definition
ADF	Australian Defence Force
Veteran	Ex-serving members of a defence force.
Contemporary veteran	Ex-serving members who served after 1999.
Deployment	Military personnel can be deployed to war or war-like operations, peacekeeping operations, and/or other operations related to national security, such as border force and emergency responses.
Problem Gambling Severity Index (PGSI)	A nine-item self-report measure of gambling problem severity that is commonly used in community based epidemiological studies.
Problem Gambling (PG)	A clinically significant gambling-related condition, which was defined by scores of ≥ 5 on the PGSI in this study.
At-Risk Gambling (ARG)	A sub-clinical gambling-related condition, which defined by scores of 1-4 on the PGSI in this study.
Gambling problems	The continuum of gambling problem severity, including both ARG and PG, which is thus defined by scores of ≥ 1 on the PGSI in this study.
MEAO	Middle East Area of Operations, comprising largely Afghanistan and Iraq.
MilHOP	Military Health Outcomes Project
Military personnel	Currently serving members of a defence force; also called 'active serving'.
PTSD	Post-traumatic Stress Disorder
Service	Time spent by an individual serving in the military

Executive summary

International evidence indicates that gambling problems may be significant issues in military and veteran populations, and can occur in the context of stressors throughout the military career; for example, following deployment to war or war-like operations. However, there is currently scant evidence from outside of the United States (US). The aims of this project were thus to evaluate the frequency of gambling problems in the post-deployment period, explore risk factors and examine the post-deployment mental health, wellbeing, and psychosocial implications of gambling problems in Australian Defence Force (ADF) military personnel.

Data for this project was collected as part of the *Middle East Area of Operations (MEAO) Prospective Health Study*, which was a two-wave cohort study of ADF members who were scheduled to deploy to the MEAO between June 2010 and June 2012. The data used in this project was from post-deployment surveys completed within four months of returning from the MEAO (n = 1,324). Surveys included the nine-item Problem Gambling Severity Index (PGSI), which was used to identify gambling problems across a continuum of severity, including clinically significant levels of Problem Gambling (PG: PGSI \geq 5), and sub-clinical conditions which were classified as At-Risk Gambling (ARG: PGSI = 1-4). These were additional to measures of probable depression (PHQ-9), PTSD (PCL-C) and alcohol use problems (AUDIT), alongside measures of distress, quality of life and post-deployment adjustment difficulties.

A range of descriptive statistics and logistic regression analyses were produced to indicate the rates, risk factors and implications of gambling problems among ADF personnel in the immediate post-deployment period. Key findings were:

- Post-deployment, 7.7 per cent of returned ADF personnel reported any gambling problems (PGSI \geq 1), with rates of 2.0 per cent for PG (PGSI \geq 5), and 5.7 per cent for ARG (PGSI = 1-4).
- Several population sub-groups were particularly vulnerable to any gambling problems (PGSI \geq 1), with higher rates observed in the context of: ADF personnel under 24 years of age (13.4 per cent of participants aged under 24 years reported gambling problems); shorter length of military service (11.0 per cent), Army service (9.7 per cent), and non-commissioned officer/other ranks (9.2 per cent).
- Rates of PG (2.0 per cent) were comparable to other clinically significant mental health conditions, including probable depression (1.2 per cent) and alcohol dependence (2.4 per cent), which were generally low. Rates of any gambling problems (PGSI \geq 1; 7.7 per cent) were high relative to harmful drinking as measured by the AUDIT (5.1 per cent).
- Gambling problems across a continuum of severity were associated with other mental health problems and indicators of poor wellbeing. For example, PG was associated with a near 9-fold increase in risk of alcohol dependence and 7-fold increases in depression and PTSD, along with 5-fold and 7-fold increases in high psychological distress and harmful drinking, respectively. ARG was associated with near 2-fold increases in PTSD, high psychological distress and poor quality of life.
- Gambling problems were also associated with post-deployment adjustment difficulties, including not wanting to talk about deployment experiences with family or friends, arguing more with intimate partners since returning, and difficulties resuming normal social activities.

The findings suggest that gambling problems, including PG and ARG, are significant issues for some Australian military personnel in the post-deployment period, occur frequently relative to other mental health and alcohol use problems, and are related to mental health, wellbeing, and post-deployment adjustment. They highlight the need for increased recognition and responses to gambling problems in military and veteran-specific contexts, particularly following deployment. These addictive behaviours and harms should be considered and addressed routinely alongside other issues including depression, PTSD and alcohol misuse.

Background

Recent attention has focused on the mental health and wellbeing of military personnel and veterans¹ following major contemporary conflicts (post-1999), which consist primarily of involvements in Iraq and Afghanistan, and peacekeeping operations in locations such as Bougainville, East Timor and the Solomon Islands. These contemporary military personnel and veterans are a significant cohort in Australia, with the Australian Defence Force (ADF) deploying over 25,000 personnel to conflicts in Afghanistan and Iraq since 2001 (Davy et al., 2012), while maintaining a continuous military presence in Afghanistan for nearly two decades.

It is important to note that the majority of military members report positive experiences during their service. However, there is also recognition that the mental health risks of service may be due, in part, to exposure to traumatic or stressful events that can occur in the context of combat, peacekeeping, humanitarian, or disaster-relief deployments, as well as non-deployment trauma that may occur during training or in other contexts (Forbes et al., 2019). Military trauma may be associated with operational exposures including coming under fire from an enemy combatant, the use of lethal force against others, being in danger of being killed or injured, and exposure to gruesome scenes (Davy et al., 2012). In addition to direct exposure, military personnel may also witness suffering of others and may be prevented or unable to intervene. These exposures can occur repeatedly across long periods in physically and psychologically demanding operational environments. However, military service can involve a diverse range of roles and experiences, whereby some personnel are more likely to have exposure to potentially traumatic events; for example, those in combat specialisations, who are often younger and comprising junior ranks.

In addition to variability across military roles, the existing evidence suggests that the mental health profiles of military personnel and veterans are complex and also vary according to current versus ex-service status, and service-related experiences. On the one hand, research on current military personnel suggests a so-called “healthy soldier effect”, whereby rates of certain mental health disorders and physical conditions are lower when compared to civilian populations, likely due mainly to selection effects (for example, assuming that potential recruits with significant mental health problems will be ineligible for military service) (McFarlane et al., 2011). Conversely, the risk of mental health conditions has been shown to increase among personnel following overseas deployment (e.g., Hoge et al., 2006), and substantially following transition out of the military and the return to civilian life (Van Hooff, 2018). The emergence of mental health conditions can also be delayed in military personnel, and may precipitate the decision to leave military service.

By way of illustration, recent research from Australia indicates that symptoms of Post-traumatic Stress Disorder (PTSD), psychological distress, and excessive alcohol use are all elevated in Australian military personnel following deployment to Afghanistan or Iraq (Davy et al., 2012). US studies have also illustrated high rates of PTSD following deployment to Iraq or Afghanistan (Hoge et al., 2006, Sareen et al., 2007, Hoge et al., 2004). Such findings are further consistent with international studies of military personnel from the UK and Canada, which have also documented high levels of alcohol use problems and the delayed emergence of PTSD in combat exposed troops after deployment to Iraq or Afghanistan (Hotopf et al., 2006, Fear et al., 2010, Stevelink et al., 2018, Zamorski et al., 2016, McFarlane, 2016).

Gambling problems, when compared to other addictive behaviours and mental health conditions, have been subject to little research among military personnel and veterans. These problems encompass a spectrum of difficulties which are characterised by (a) persistent maladaptive gambling behaviours (e.g., gambling more than intended, chasing losses) that precede (b) negative consequences from gambling, or so-called ‘gambling-related harms’ (e.g., financial problems, relationship breakdown). The severe end of this gambling continuum includes psychiatric conditions that could warrant a diagnosis of Gambling Disorder, which is classified as a Substance-

1 Military personnel refer to current serving members, whereas veterans refers to ex-serving members of the defence force

Related and Addictive Disorder in the current edition of Diagnostic and Statistical Manual of Mental Disorders (DSM-5; American Psychiatric Association, 2013). In contrast, the term Problem Gambling (PG) is also used commonly to refer to a somewhat broader conceptualisation of conditions that are defined by impaired control and significant adverse consequences (with or without other hallmarks of 'addictive' disorders) (Williams and Volberg, 2014). This terminology is typically associated with a public health framework which recognises a continuum of gambling severity that also incorporates sub-clinical problems which are often described in terms of low-risk, moderate-risk or at-risk gambling. Although existing literature has had a predominant focus on clinically significant levels of PG, these subclinical problems are also important and may account for up to 85 per cent of the burden of gambling harm at the population level (Browne et al., 2017). They are also the indicated targets of early intervention or secondary prevention strategies that are necessary to help prevent the most severe consequences of gambling before they occur. This focus on prevention is critical given links with severe PG and serious consequences for individuals (e.g., suicidality) (Cowlshaw and Kessler, 2016) and families (e.g., relationship problems, domestic violence) (Cowlshaw et al., 2016b, Roberts et al., 2018).

For purposes of this report, the term **Problem Gambling (PG)** will be used to refer to severe and clinically significant gambling-related conditions (including but not limited to psychiatric diagnoses), consistent with a public health framework (Korn and Shaffer, 1999, Shaffer and Korn, 2002). Furthermore, the term **At-Risk Gambling (ARG)** will be used to refer to subclinical problems, consistent with prior research (Cowlshaw and Kessler, 2016, Cowlshaw et al., 2020). The term 'gambling problems' will be used to describe the full spectrum of gambling problem severity, which thus subsumes both PG and ARG.

Gambling problems among military personnel and veterans

There is no research from Australia that has addressed gambling problems among currently-serving military personnel at any stage in their career. However, there is modest evidence regarding these issues in Australian veterans once they have left the military, as well as studies from other international jurisdictions which will be reviewed below. As discussed previously, the mental health profiles of currently-serving and ex-serving ADF personnel can differ significantly, meaning that findings about veterans will not generalise readily to current personnel (Van Hooff, 2018). Similarly, there are known differences in the mental health concerns of personnel from different countries (Vermetten et al., 2014), which may be due to national differences in selection processes, operational missions and tempo (i.e., duration and frequency of operations), as well post-deployment environments. As such, the findings reviewed below about veterans and personnel from other jurisdictions should be viewed in the context of these differences, which also highlight the need for focussed examination of these issues within the ADF population.

As far as we can ascertain, there have been only two prior studies of gambling problems in Vietnam-era veterans from Australia. These include preliminary estimates which were derived in the 1990s as part of the Vietnam Veterans Health Study, which indicated rates of 4.6 per cent (1.6 per cent) for lifetime (past month) PG, as identified by the Diagnostic Interview Schedule (O'Toole et al., 1996). Subsequent analyses of this data also indicated 32 per cent of these Vietnam-era veterans with PG that exhibited co-occurring PTSD (O'Toole et al., 1998). More recently, a small Australian study of veterans in PTSD treatment ($n = 153$) identified extremely high numbers of patients with PG (29 per cent) in this service use environment (Biddle et al., 2005).

There are greater numbers of studies of gambling problems among military personnel and veterans from the US. These include one study of a national sample of veterans that identified a past-year prevalence rate for gambling problems of 2.2 per cent when defined by a brief screening measure (Stefanovics et al., 2017); which is around twice the rate often reported in studies of civilian populations from this jurisdiction (Petty and Blanco, 2013).

Additional studies of community-based samples of US veterans which have utilised more comprehensive measures suggest higher rates of past-year gambling problems of 4.2 per cent (Whiting et al., 2016) and lifetime prevalence rates of 10 per cent (Westermeyer et al., 2005). Furthermore, higher rates have also been observed in Veterans Affairs (VA) health services in the US, which have suggested between 3 per cent (Weis and Manos, 2007) and 20 per cent (Hierholzer et al., 2010) of patients that report histories of at least some gambling problems, with higher levels typically observed in services for substance use disorders (Wickwire Jr et al., 2008, Davis et al., 2017, Nelson and Oehlert, 2008) and among veterans with PTSD (Lusk et al., 2017). Outside of the US, we know of only one study from the UK which reported findings from a small sub-group of veterans in the 2007 Adult Psychiatric Morbidity Survey (APMS). This study identified 1.4 per cent and 3.6 per cent of participants that reported lifetime probable PG (3-4 DSM-IV criteria) and any gambling problems (1+ criteria), respectively (Dighton et al., 2018).

In addition to findings regarding prevalence, these existing studies of military personnel and veterans have also suggested a potential range of correlates of gambling problems that may signal risk factors or implications of relevant conditions in these populations. The correlates that have been emphasised in relevant studies include:

- a. socio-demographic characteristics, such as male gender (Whiting et al., 2016) and lower education (Stefanovics et al., 2017)
- b. service and deployment-related characteristics (e.g., Navy service) (Stefanovics et al., 2017)
- c. additional mental health problems such as PTSD, depression and substance use problems (Whiting et al., 2016)
- d. psychosocial attributes including social support and life stressors (Whiting et al., 2016), as well as suicide risk (Levy and Tracy, 2018) and non-partner aggression (Davis et al., 2017).

The current study

On the basis of available evidence from research on military personnel and veterans from the US, and to a lesser extent from Australian studies of Vietnam-era veterans, it seems likely that gambling problems could comprise significant issues among currently serving personnel from Australia. Furthermore, these expectations are supported by additional lines of reasoning and evidence, as follows:

- Population-based studies from Australia indicate that young males aged 18–24 continue to be particularly vulnerable to gambling problems (Armstrong and Carroll, 2017). This socio-demographic group are also a substantial subgroup of Australian military personnel (and particularly Army personnel).
- Affective and anxiety disorders are all significant conditions among Australian military personnel (McFarlane et al., 2011), with additional evidence suggesting that gambling problems co-occur frequently with these mental health issues (Lorains et al., 2011, Cowlshaw et al., 2014, Dowling et al., 2015).
- Studies suggest that levels of risky drinking (Waller et al., 2015) and harmful alcohol use (McFarlane et al., 2011) may be lower among Australian military personnel and veterans, when compared to civilian populations, but are still important issues on the basis of overall prevalence (estimated rates of hazardous and harmful drinking, and alcohol dependence are 36 per cent, 9 per cent and 4 per cent, respectively) and health or social impacts (Waller et al., 2015). In the context of work-related stressors, alcohol use has been conceptualised in terms of drinking to cope or self-medication (Frone, 2016), while gambling problems are also viewed analogously in terms of gambling to escape or regulate negative mood (Thomas et al., 2009a). In the absence of sedative pharmacological properties that characterise alcohol, however, there are likely to be fewer norms and policies which regulate gambling consumption (e.g., around work hours), which may also encourage gambling in order to regulate negative mood.

Given the dearth of evidence regarding gambling problems among Australian military personnel, there is strong need for preliminary research which can determine the scope and importance of the problems. As such, the aims of the current project were to:

1. evaluate the frequency of gambling problems among current full-time Australian military personnel after deployment
2. explore risk factors for gambling problems and determine vulnerable groups which evidence greatest need for support or intervention services
3. examine the mental health, wellbeing and psychosocial implications of gambling problems for ADF members, including implications for post-deployment adjustment of military personnel.

Approach

This project is based on the secondary analysis of data from the post-deployment survey of a prospective cohort study of ADF personnel deployed to Afghanistan and Iraq, referred to collectively as the Middle East Area of Operations (MEAO). The MEAO Prospective Health Study was one of four studies that comprised the Military Health Outcomes Program (MilHOP), which was a body of research commissioned by the Department of Defence to determine the impact of operational deployment on the health and wellbeing of military personnel. MilHOP includes the 2010 ADF Mental Health Prevalence and Wellbeing Study, the Middle East Areas of Operations (MEAO) Census Health Study, the MEAO Prospective Health Study (from which data for this study is derived), and the MEAO Mortality and Cancer Incidence Health Study.

In the context of the MilHOP research, the specific aims of the MEAO Prospective Health Study were to measure the health and adjustment of personnel prior to deployment and again after returning home. The MEAO Prospective Health study examined life experiences, trauma exposure, and information on previous military service. The sampling frame for the MEAO Prospective Health Study comprised all ADF members who had deployed to the MEAO after June 2010, and returned to Australia by June 2012. These included personnel who had deployed for any length of time, regardless of service, gender and rank, but excluded individuals who were not ADF members (e.g., civilian contractors, Australian Federal Police). Participants who were deployed to the MEAO during the sampling time frame were invited to participate in the post-deployment survey within four months following return from the MEAO.

Approximately four months prior to deployment, current serving ADF personnel who were scheduled to deploy to the MEAO were mailed an invitation pack including a self-report questionnaire; they were also given the option to complete an online version. The pre-deployment questionnaire consisted of: a brief deployment history questionnaire; a health questionnaire; and personality and resilience insert. Participants were followed up four months following return from deployment. The post-deployment questionnaire consisted of a health questionnaire and a deployment experiences questionnaire.

A standardised measure of gambling problems, called the Problem Gambling Severity Index (PGSI), was administered in the context of both pre-deployment and post-deployment surveys. However, the scale was included only part-way through the data collection period for the pre-deployment survey, via a study amendment. As such, the measure was unavailable for the entire sample at pre-deployment. A series of preliminary analyses indicated substantial levels of missing data for the PGSI at pre-deployment, and large differences between respondents with and without this data. For example, Navy and Air Force personnel were substantially more likely to be missing this pre-deployment information on the PGSI, when compared to Army personnel (see **Appendix A**). As such, the decision was made to focus analyses primarily on post-deployment surveys for which the PGSI was administered and potentially available for all respondents. All subsequent sections and measures thus refer to this post-deployment survey data, except where indicated. **Appendix B** provides a participant flow chart which indicates the number of participants included and excluded at each stage of the study.

Measures

The MEAO Prospective Health Study involved administration of a range of survey measures at post-deployment and a selection of these were considered for purposes of the current report.

Socio-demographic characteristics included age (18–24, 25–30, 31–39, and 40+ years), sex, relationship status (Single/Never married; Married/De facto; Divorced/Separated/Other), and education (Secondary school up

to Grade 10; Secondary school grades 11-12; Certificate; Diploma; Bachelor's Degree; Postgraduate qualification; Not reported).

Service-related characteristics included ADF service (Navy, Army, Air Force), Rank (Commissioned Officer; Non-Commissioned Officer / Other ranks), and length of service (0–4, 5–9, 10–19 and 20+ years).

Gambling problems were measured using the Problem Gambling Severity Index (PGSI) (Ferris and Wynne, 2001). The PGSI comprises nine items about experiences which are scored on a four-point scale (0=never, 3=almost always), and have high internal consistency (Cronbach's $\alpha = 0.90$) and strong associations with comparable measures (Williams and Volberg, 2014). In this study, the Cronbach's α internal consistency reliability for the PGSI at post-deployment was $\alpha = 0.86$.

Although the PGSI typically asks about problems in the past year, the measure was modified for this study such that items referenced "Since the beginning of your last deployment..." The PGSI items are summated conventionally to derive four interpretive categories: no problems (PGSI=0), low-risk (PGSI=1–2), moderate-risk (PGSI=3–7) and PG (PGSI=8+). However, the current study used a criterion of PGSI ≥ 5 for PG, which has been shown to yield greatest classification accuracy relative to clinician ratings involving detailed case conceptualisations, while scores of PGSI 1–4 indicated ARG, consistent with prior research (Cowlshaw et al., 2017, Williams and Volberg, 2014, Cowlshaw et al., 2020).

Depression was assessed using the nine-item Patient Health Questionnaire (PHQ-9). Each item comprising the PHQ-9 evaluates the frequency of one of the nine DSM-IV criteria for major depression over the past two weeks. The PHQ-9 has been validated against clinical diagnoses from medical professionals and has superior operating characteristics to alternative scales (Kroenke et al., 2001). In this study, the Cronbach's α internal consistency reliability for the PHQ-9 at post-deployment was $\alpha = 0.89$. A summed score of ≥ 10 on the PHQ-9 was used to identify major depression in this study (Kroenke et al., 2001).

Post-traumatic Stress Disorders (PTSD) symptoms were assessed using the Post-traumatic Stress Disorder checklist civilian version (PCL-C). This comprises a 17-item self-administered questionnaire which has been widely used for assessing PTSD symptoms over the past month. The PCL-C has excellent test-retest reliability and internal consistency, and has been used extensively in the context of population-based research (Weathers et al., 1993). A total symptom severity score was obtained by summing scores across items, whereby higher scores indicate greater severity of PTSD symptoms. In this study, the Cronbach's α internal consistency reliability for the PCL-C at post-deployment was $\alpha = 0.95$. A score of 33 used to identify probable PTSD in this study (Weathers et al., 1993).

Alcohol use problems were measured using the 10-item Alcohol Use Disorders Identification Test (AUDIT). This scale examines quantity and frequency of alcohol consumption, potential alcohol dependence symptoms, and problems related to alcohol, with a wide recall reference period varying for items across past week, month, and year. The AUDIT is considered valid and reliable (Reinert and Allen, 2007). The first eight questions of the AUDIT are scored using a five-point likert scale (scored 0-4), while the last two questions use a three-point scale (scored 0, 2 or 4). Given that the AUDIT does not comprise a unidimensional scale, the Cronbach's α internal consistency reliability was not informative and was not produced. A total score was derived by summing item responses, with summed scores ≥ 16 and ≥ 20 suggesting harmful drinking and probable alcohol dependence, respectively (Babor et al., 2001).

Psychological distress was assessed using the 10-item Kessler distress scale (K10). The K10 is a widely used and validated measure of non-specific psychological distress measured over the past four weeks (Kessler et al., 2003), which has demonstrated high levels of diagnostic accuracy, including in Australian military populations (Searle et al., 2015). Summed scores can be used to signal risk of mental health problems and high levels of psychological distress (K10 ≥ 20) (Slade et al., 2011). The scale was designed to be most sensitive around the

threshold for clinically significant non-specific distress in order to maximise discrimination of cases. In this study, the Cronbach's α internal consistency reliability for the K10 at post-deployment was $\alpha = 0.92$.

Post-deployment experiences were measured using nine items relating to post-deployment transition experiences, which were originally used in the Health and Wellbeing of UK Armed Forces Personnel Cohort Study and were adapted for the ADF (Stevellink et al., 2018). These questions asked about "In the weeks after I came home...", and comprised the following items which were scored using a binary response scale (Disagree = 0, Agree = 1):

- I was well supported by the military [which was reverse scored in the analyses]
- I found it difficult to adjust to being back home
- People didn't understand what I had been through
- I did not want to talk about my experiences with my family / friends
- I found it difficult to resume my normal social activities
- I had serious financial problems
- I argued more with my spouse partner [there was a 'Not Applicable' response option for this item, which was re-coded to 'Disagree']
- I have been let down by people who I thought would stand by me
- I had other major problems on return from deployment

These items were considered as separate item-level measures in the analyses.

Data analysis plan

Data-file management and preliminary exploration were conducted using SPSS version 25, while Program R (version 3.4.3) and MPlus (version 8) were used subsequently for substantive analyses. These included preliminary analyses involving production of descriptive statistics to characterise the sample at both pre-deployment and post-deployment, and quantify the extent of missing data (e.g., due to item non-response and study drop-out over time). The latter also comprised Pearson χ^2 -tests followed by logistic regression models which were conducted to screen for systematic patterns of missing data across socio-demographic and service-related characteristics. These were followed by substantive analyses which were conducted subsequently and across two main stages.

The first stage comprised a series of descriptive statistics including item-level analyses to quantify the frequencies of specific gambling problems (as operationalised by PGSI items). Aggregate scale scores for the PGSI were then formed and defined using cut-off criteria that distinguished gambling problems across a continuum of severity. Prevalence point estimates (and 95 per cent Confidence Intervals; CIs) were thus calculated to indicate levels of (a) PG (PGSI ≥ 5) and (b) ARG (PGSI = 1-4). These prevalence estimates were considered relative to the estimated rates of other mental health conditions (e.g., depression) and substance use problems (e.g., harmful drinking).

The second stage involved a series of covariate analyses which were initially conducted to examine variability in gambling problems according to socio-demographic and service-related characteristics. These comprised logistic regression models in which gambling problems were specified as the endogenous (dependent) variable. A subsequent series of logistic regression models were also estimated to examine the implications of gambling problems for mental health, wellbeing and post-deployment adjustment. These specified gambling problems as the exogenous predictor, while mental health and wellbeing indicators were specified as outcome variables in separate models. Significant socio-demographic and service-related characteristics were also included as covariates. Odds Ratios (ORs) and adjusted Odds Ratios (aORs), along with 95 per cent Confidence Intervals (CIs), were produced in order to quantify the magnitude of associations in these analyses.

Results

Preliminary analyses

There were N = 3074 ADF personnel who deployed to the MEAO during the data collection period, and n = 1871 completed pre-deployment questionnaires (response rate = 60.9 per cent). However, the PSGI was only added to these surveys part-way through the data collection period, via a study amendment, and was thus unavailable for the entire sample. Preliminary analyses thus indicated substantial missing data on the PSGI at pre-deployment, as well as large systematic differences in respondents with and without these scores. As such, the decision was made to focus analyses on post-deployment surveys, for which the PSGI was administered and potentially available for all respondents. Results from the aforementioned analyses of missing data on the PSGI at pre-deployment are reported in **Appendix A**. **Appendix B** also provides a flow chart indicating the number of participants included and excluded from each stage of the study.

Post-deployment surveys were returned by n = 1324 respondents, which corresponds to 43.1 per cent of the total eligible population of deployed personnel (N = 3074). Table 1 shows the socio-demographic and service-related characteristics of the sample. As can be seen, the respondents were predominately male, aged less than 40, and most were in married/de facto relationships. The majority of participants reported service with the Army, and with the ADF for less than 10 years. Additional data regarding length of deployment in the MEAO indicated around one third of participants were deployed for 6–7 months (30.5 per cent); a third were deployed for more than 8 months (39.3 per cent), and the remaining participants were deployed for 5 months or less (30.2 per cent). Supplementary findings from analyses comparing both pre-deployment and post-deployment samples, and differences over time, are also presented in **Appendix A**.

Table 1. Participant characteristics for the post-deployment sample (n = 1,324)

	n	%
Sex (male)	1197	90.4
Age, years		
18–24	397	30.0
25–30	376	28.4
31–39	296	22.4
40+	255	19.3
Relationship status		
Married/de facto	920	69.5
Single, never married	347	26.2
Divorced/Separated/Other	34	2.6
Education (high school or less)	702	53.0
Service		
Army	925	69.9
Navy	330	24.9

	n	%
Air Force	69	5.2
Rank (NCO/Other ranks)	1053	79.5
Length of service (years)		
0–4	494	37.3
5–9	382	28.9
10–19	250	18.9
20+	183	13.8

Descriptive analyses

Table 2 shows findings from descriptive analyses of the rates of gambling problems across a continuum of severity relative to other common mental health conditions. As can be seen, there were 2.0 per cent of ADF personnel that were classified as PGs according to the PGSI, while 5.7 per cent were ARGs, with a combined total 7.7 per cent (95 per cent CI = 6.4 per cent to 9.3 per cent) reporting any gambling problems across a continuum of severity.

The estimated rate of PG in this study (2.0 per cent) was comparable to rates of probable depression (1.2 per cent) and alcohol dependence (2.4 per cent), but was lower than probable PTSD (11.3 per cent). The estimated rate of any gambling problems in this study (7.7 per cent) was high relative to harmful drinking as measured by the AUDIT (5.1 per cent). These comparisons should be viewed cautiously given different reference periods across measures of gambling problems (since beginning of last deployment), depression (past-month), PTSD (past-month), and alcohol problems (since beginning of last deployment).

Table 2. Gambling problem rates

	n	%	95% CI	
			LB	UB
Gambling problems (since beginning of last deployment)				
At-Risk Gambling (ARG) (PGSI = 1-4)	75	5.7	4.5	7.1
Problem Gambling (PG) (PGSI ≥ 5)	27	2.0	1.4	3.0
Any gambling problems (PGSI ≥ 1)	102	7.7	6.4	9.3
Depression (past-month)	16	1.2	0.7	2.0
PTSD (past-month)	149	11.3	9.6	13.1
Alcohol problems (since beginning of last deployment)				
Alcohol dependence	32	2.4	1.7	3.4
Harmful drinking	68	5.1	4.0	6.5

Notes. PGSI = Problem Gambling Severity Index; K10 = Kessler 10; PHQ-9 = Patient Health Questionnaire-9; PCL-5 = PTSD Checklist for DSM-5; AUDIT = Alcohol Use Disorders Identification Test.

Further descriptive analyses were conducted at the item-level to highlight the most common indicators of gambling problems (as operationalised by non-zero scores for all PGSI items) that were reported by participants who exhibited any such problems across a continuum of severity ($n = 102$). The results of these are shown in Table 3, which indicates that the most common gambling problems involved *betting more than you could afford to lose*, *needing to gamble with larger amounts to get the same feeling of excitement*, and *returning another day to try and win back money that was lost* (i.e., chasing losses). Problems which comprised the negative consequences of gambling, including financial difficulties and health issues (including stress or anxiety) attributed to gambling, were reported by 5–10 per cent of this sub-sample. By way of illustration, among participants who reported any gambling problems post-deployment ($n = 102$), there were around half (51.0 per cent) that reported *betting more than you could afford to lose*, while 4.9 per cent reported having *borrowed money or sold anything to get money gamble*.

Table 3. Problem Gambling Severity Index (PGSI) items

PGSI Items	Gambling problems post-deployment (n = 102)	
	n	%
Have you needed to gamble with larger amounts of money to get the same feeling of excitement?	58	56.9
Have you bet more than you could really afford to lose?	52	51.0
When you gambled, did you go back another day to try to win back the money you lost?	46	45.1
Have you felt guilty about the way you gamble or what happens when you gamble?	39	38.2
Have you felt that you might have a problem with gambling?	34	33.3
Have people criticized your betting or told you that you had a gambling problem, regardless of whether or not you thought it was true?	25	24.5
Has gambling caused you any health problems, including stress or anxiety?	10	9.8
Has your gambling caused any financial problems for you or your household?	7	6.9
Have you borrowed money or sold anything to get money to gamble?	≤ 5 ^φ	NA

Notes. PGSI = Problem Gambling Severity Index. Items reference time since beginning last deployment. ^φ = Small cell size suppressed.

Regression analyses

For purposes of covariate analyses, Multiple Imputation (MI) was used to address missing data from item non-response and attrition between pre-deployment and post-deployment surveys, thus minimising potential biases attributable to drop-out (see **Appendix A**). This involved imputation of $k = 100$ datasets in MPlus, which included all aforementioned measures (including ADF service and age) at pre-deployment and post-deployment in the imputation model. This ability to include auxiliary variables in the imputation process is a major strength of MI techniques, and maximises the likelihood of data that are Missing At Random (MAR). This is because the latter is a function of both the pattern of missing data and the inclusion of variables that predict 'missingness' in the analyses (and on this basis MI techniques are highly recommended) (Graham, 2009). All covariate analyses were based on the total sample comprising $n = 1871$ (see **Appendix B**).

Risk factors for gambling problems at post-deployment

The initial series of logistic regression models were estimated to examine the socio-demographic and service-related risk factors for gambling problems. For these analyses, a binary measure of any gambling problems (PGSI ≥ 1) was specified as the outcome (dependent) variable, to identify participants that would be the main focus of gambling harm reduction strategies. This measure was regressed on socio-demographic and service-related characteristics that were explanatory variables. The latter were specified using dummy variables (reference category in each model is grey), and were evaluated in separate models which estimated bivariate associations. Bivariate models were suitable given the primary focus on identifying discernible risk factors for gambling problems. Results from these models are in Table 4.

Table 4. Bivariate logistic regression models indicating predictors of any gambling problems (PGSI ≥ 1) at post-deployment

	Frequencies		Logistic regression			
	n	%	OR	95% CI		
				LB	UB	
Sex						
Male	97	8.4				
Female	5	4.2	0.60		0.33	1.08
Age						
18–24	51	13.4				
25–30	28	7.8	0.89		0.65	1.21
31–39	15	5.3	0.62	**	0.44	0.88
40+	8	3.3	0.30	***	0.18	0.51
Relationship status						
Married/de facto	73	8.3				
Single, never married	26	7.8	1.16		0.87	1.55
D/S/O	$\leq 5^\dagger$	NA	1.09		0.50	2.35
Education						
High school or less	68	10.1	1.28		0.98	1.68
Post-high school	34	5.8				
Service						
Army	86	9.7				
Navy	$\leq 5^\dagger$	NA	0.61		0.32	1.18
Air Force	12	3.8	0.53	***	0.37	0.76
Rank						
Commissioned Officer	8	3.4	0.41	***	0.249	0.663
NCO/ Other ranks	92	9.2				

	Frequencies		Logistic regression			
	n	%	OR	95% CI		
				LB	UB	
Length of service (years)						
0-4	52	11.0				
5-9	31	8.5	0.90		0.67	1.21
10-19	12	5.0	0.77		0.54	1.10
20+	7	4.0	0.36	***	0.21	0.61

Note: ϕ = Small cell size suppressed. *** = $p < 0.001$, ** = $p < 0.01$, * = $p < 0.05$.

As can be seen from Table 4, the likelihood of reporting any gambling problems at post-deployment was significantly associated with age and service-related characteristics including length of service, rank, and ADF service. By way of illustration, there were higher rates of gambling problems among personnel aged 18–24 (13.4 per cent), when compared to those aged 31–39 (5.3 per cent) and 40+ (3.3 per cent), while 0–4 years of service was also associated with higher rates (11.0 per cent) when compared to 20+ years of service (4.0 per cent). Increased rates were also reported by NCOs / Other ranks (9.2 per cent), relative to Commissioned Officers (3.4 per cent), and by Army personnel (9.7 per cent) relative to the Air Force personnel (3.8 per cent). There were no significant associations with additional socio-demographic characteristics including gender, relationship and education status. However, such findings should be viewed in the context of small numbers of participants comprising certain sub-groups (e.g., females), and thus low levels of statistical power for these comparisons.

Mental health and psychosocial implications of gambling problems at post-deployment

An additional series of logistic regression models were estimated to examine cross-sectional associations with gambling problems and various indicators of mental health, wellbeing and psychosocial adjustment. For purposes of these analyses, the measures of post-deployment mental health and adjustment were specified as outcome (dependent) variables in separate models, while gambling problems were treated as explanatory (independent) variables. The latter were specified using dummy variables which compared both ARG and PG with respondents reporting no gambling problems (PGSI = 0). It is important to note that while these models treat gambling problems as explanatory variables (which predict measures of mental health and adjustment), the models were based on cross-sectional data and directionality of effects cannot be assumed. In order to reduce the risk of confounding, these models also included as covariates the socio-demographic and service-related characteristics that were identified earlier as being significantly associated with gambling problems (see Table 4), including age, service and rank. Length of service was not included in analyses given overlap with age, while ADF Service was modelled as a binary variable (Army versus Navy/Airforce) in order to avoid empty cells.

Table 5 summarises results from analyses of mental health and wellbeing outcomes, which suggested particularly strong associations with PG. For example, when compared to participants reporting no gambling problems, PG was associated with an almost seven-fold increase in the likelihood of both probable major depression and PTSD, and an almost nine-fold increase in alcohol dependence. PG was also associated with a near seven-fold increase in the likelihood of harmful drinking, a five-fold increase in high psychological distress, and an almost three-fold increase in reports of fair-to-poor QOL. There were additional associations also observed with ARG (compared to

no gambling problems), which were comparably modest but nevertheless indicated more than two-fold increases in rates of probable PTSD, high psychological distress, harmful drinking and fair-to-poor QOL. These effects were all significant when controlling for effects of age, service and rank.

Table 6 summarises findings from regression models of outcomes which comprised post-deployment adjustment experiences, which were all considered in analyses with the exception of one item addressing serious financial problems (which was not estimated given limited variability on this measure). Again, it is important to note that while these models treat gambling problems as explanatory variables (which predict binary measures of post-deployment adjustment difficulties), the models were based on cross-sectional data and directionality of effects cannot be assumed.

As can be seen from Table 6, PG was significantly associated with post-deployment adjustment problems including not wanting to talk about experiences with family and friends, arguing more with intimate partners, as well as reports of difficulties resuming normal social activities (which were all characterised by more than three-fold increases in risk). By way of illustration, there were 55.6 per cent of participants who reported PG that also reported not wanting to talk about experiences with family and friends, relative to 29.3 per cent among participants that reported no gambling problems. ARG was again associated with comparably modest yet statistically significant increases in rates of several adjustment problems including reports of feeling let down by people who they thought would stand by them (OR = 1.76) and difficulties resuming normal social activities (OR = 1.66).

Table 5. Bivariate logistic regression models specifying gambling problems as predictors of mental health and wellbeing indicators

	No problems (0) (n= 1166)		ARG (1) (n= 75)		PG (2) (n= 27)		Regression models					
	%	n	%	n	%	n	Vs. (1)			Vs. (2)		
							OR	95% CI		OR	95% CI	
								LB	UB		LB	UB
Depression	0.9	11	NA	< 5 ^φ	NA	< 5 ^φ	1.48	0.84	2.62	6.94 ***	2.68	17.95
PTSD	10.3	120	20.0	15	40.7	11	2.34 ***	1.66	3.30	6.88 ***	3.21	14.74
Alcohol dependence	1.8	21	10.7	8	NA	< 5 ^φ	1.88	0.88	4.01	8.69 ***	2.77	27.32
High distress	10.3	120	21.3	16	37.0	10	2.02 ***	1.39	2.94	5.19 ***	2.30	11.69
Harmful drinking	3.8	44	24.0	18	18.5	5	2.47 ***	1.51	4.06	6.71 ***	2.64	17.07
Quality of life	8.7	102	18.7	14	18.5	5	2.52 ***	1.76	3.62	2.87 ***	1.13	7.29

Note: ARG = At-Risk Gambling (PGSI = 1 – 4), PG = Problem Gambling (PGSI ≥ 5). ORs were derived from logistic regression models which included age, service and rank as control variables, while using data following MI procedures to address missing values (n = 1871). Frequency statistics were produced for descriptive purposes to supplement these regression analyses, and were based on sub-samples with complete data on relevant measures from the non-imputed data-set (n = 1,324). ^φ = Small cell size suppressed. *** = p < 0.001, ** = p < 0.01, * = p < 0.05

Table 6. Bivariate logistic regression models specifying gambling problems as predictors of post-deployment difficulties

	No problems (0) (n= 1166)		ARG (1) (n= 75)		PG (2) (n= 27)		Regression models					
							(0) Vs. (1)			Vs. (2)		
	%	n	%	n	%	n	OR	95% CI		OR	95% CI	
								LB	UB		LB	UB
Felt unsupported by the military	16.5	192	21.3	16	NA	< 5 ^φ	1.15	0.79	1.68	0.84	0.28	2.47
Found it difficult to adjust being back home	30.7	358	48.0	36	55.6	15	1.55 **	1.14	2.10	2.80 *	1.27	6.17
People didn't understand what I had been through	46.7	544	62.7	47	66.7	18	1.36	0.99	1.87	2.77 *	1.17	6.56
Did not want to talk about experiences with family/friends	29.3	342	46.7	35	55.6	15	1.35	0.98	1.86	3.69 **	1.67	8.13
Found it difficult to resume normal social activities	22.0	256	38.7	29	44.4	12	1.66 **	1.18	2.33	3.18 **	1.42	7.09
Had serious financial problems	0.9	11	NA	< 5 ^φ	NA	< 5 ^φ	-	-	-	-	-	--
Argued more with my spouse/partner	19.3	225	22.7	17	40.7	11	1.22	0.86	1.73	3.35 **	1.54	7.31
Have been let down by people I thought would stand by me	9.7	113	26.7	20	22.2	6	1.76 **	1.17	2.65	2.64 *	1.05	6.62
Other major problems on return	6.9	81	13.3	10	22.2	6	1.64 *	1.02	2.65	3.59 **	1.41	9.15

Note: ARG = At-Risk Gambling (PGSI = 1 – 4), PG = Problem Gambling (PGSI ≥ 5). ORs were derived from logistic regression models which included age, service and rank as control variables, while using data following MI procedures to address missing values (n = 1871). Frequency statistics were produced for descriptive purposes to supplement these regression analyses, and were based on sub-samples with complete data on relevant measures from the non-imputed data-set (n = 1,324). ^φ = Small cell size suppressed. *** = p < 0.001, ** = p < 0.01, * = p < 0.05

Conclusions

To our knowledge, this is the first Australian study of gambling problems in currently serving military personnel, which extends prior research conducted among Australian Vietnam-era veterans (O'Toole et al., 1996), as well as international studies of both military and veteran populations which are largely from the US (Davis et al., 2017, Weis and Manos, 2007, Westermeyer et al., 2013). It provides new evidence regarding the mental health status of military personnel in Australia, as well as their adjustment in the immediate post-deployment period.

The study involved analyses of data from ADF personnel who deployed to the Middle East Area of Operations (MEAO) between 2010 and 2012, and reported specific findings from a post-deployment survey that was completed by $n = 1324$ personnel within four months of return from the MEAO. The main results indicated 7.7 per cent of military personnel reported at least some gambling problems either during or post-deployment. This included 2.0 per cent that were distinguished by clinically significant levels of Problem Gambling (PG: PGSI ≥ 5), and 5.7 per cent that were classified in terms of sub-clinical levels of At-Risk Gambling (ARG: 1–4).

It is important to note that these items from the PGSI were adapted and referenced the period since beginning the last deployment, which were typically in excess of six months. Moreover, during deployment gambling opportunities were likely significantly restricted to informal types such as card games, given severely limited internet connectivity while on deployment, as well as access to land-based gambling venues. Accordingly, while the reference period for PGSI (since beginning of last deployment) was probably around the past-year for many respondents, there was only a proportion of this period that was spent in the Australian community, and thus a widely accessible gambling environment.

The findings suggest that gambling problems were significant post-deployment issues relative to other mental health conditions, taking into consideration the differences in time periods referenced in the measurement scales. Assuming that prevalence estimates from the current sample are reasonably representative, then this would suggest that around 237 personnel deployed to the MEAO have gambling problems in the immediate post-deployment period. The prevalence point estimate for PG (2.0 per cent) was also lower than past-month probable PTSD (11.3 per cent), but was comparable to rates of past-month probable depression (1.2 per cent) and alcohol dependence (2.4 per cent). The latter condition was also referenced to the period since beginning the last deployment. Furthermore, levels of any gambling problems (7.7 per cent), which also included ARG, were high relative to harmful drinking (5.1 per cent). Depression (McFarlane et al., 2011), and alcohol use problems (Waller et al., 2015) are both important concerns for military personnel, and on the basis of prevalence alone this study indicates that gambling problems are also significant issues post-deployment.

Further analyses also indicated several population sub-groups that were particularly vulnerable to gambling problems, with high levels of any problems observed among ADF personnel who were aged 18–24 (13.4 per cent), reported 0–4 years of military service (11.0 per cent), served in the Army (9.7 per cent), and comprised NCOs / other ranks (9.2 per cent). We are not aware of existing studies which have identified such service-related risk factors for gambling problems, although findings regarding age (and length of service by extension) are consistent with literature indicating that young adults, and particularly young males, are a significant at-risk group (Cowlshaw et al., 2017, Armstrong and Carroll, 2017)². In the context of finite resources for harm reduction initiatives, these findings may suggest value from strategies focussing selectively on these readily identifiable at-risk groups. For example, evidence of variable rates according to age and ADF service may suggest particular benefits from strategies that target more junior Army personnel, particularly in the post-deployment period.

² Although gender was not significantly associated with gambling problems in this study, there was a trend towards higher levels among males (8.4 per cent) relative to females (4.2 per cent), which suggests that the absence of discernible differences was likely attributable to the small number of female personnel in this study, and thus low levels of statistical power.

The current study demonstrated associations involving gambling problems and various indicators of mental health and wellbeing. These links were particularly strong when considering clinically significant levels of PG (PGSI \geq 5), which when compared to participants with no problems, were associated with more than 6-fold increases in rates of other mental health conditions including depression, PTSD, and alcohol dependence. These associations suggest substantial levels of comorbidity with PTSD in particular (there were around 41 per cent of PGs that also exhibited probable PTSD). Furthermore, PG was associated with a near seven-fold increase in harmful drinking, a five-fold increase in high psychological distress, and an almost three-fold increase in reports of fair to poor QOL.

The findings are consistent with broader literature indicating common co-occurrence of gambling problems with other mental health and substance use concerns (Cowlshaw et al., 2016a, Cowlshaw et al., 2014, Lorains et al., 2011), which may be explained in various ways. There may be shared clinical features of gambling problems and PTSD, in particular, with prominent dimensions of both conditions involving dissociation, impulsivity, and reckless and self-destructive behaviour (Ledgerwood and Petry, 2006). Furthermore, patterns of co-occurrence may reflect shared vulnerabilities for multiple mental health conditions, including genetic vulnerabilities, which have been shown to account for one-half to two-thirds of the association between gambling and alcohol problems, in particular (Slutske et al., 2013). Biological vulnerabilities related to increased impulsivity and increased emotionality, such as serotonergic and noradrenergic processes, are also proposed to drive the relationships between gambling problems and mood disorders (Ledgerwood and Petry, 2010).

While certain vulnerabilities may suggest shared pathways to gambling problems and co-morbid psychopathology, once established, gambling problems can then maintain or exacerbate psychopathology. Specifically, gambling losses, strategies to fund gambling (e.g., theft, selling belongings) and subsequent experiences of guilt, shame, and desperation can have significant impacts on mental health and wellbeing (Fong, 2005). Simultaneously, psychopathology (including both depression and PTSD) can drive and maintain gambling problems. For example, distress or negative mood states associated with psychiatric disorders might precipitate an individual seeking maladaptive ways to decrease affect, consistent with conceptual notions of 'gambling to escape' (Thomas et al., 2009b). This is pertinent given evidence suggesting high rates of trauma exposure among PGs (Scherrer et al., 2007). It has been argued previously that traumatic experiences may precede the development of gambling problems (Roberts et al., 2017). Specifically, trauma is thought to play an important role in the initiation and course of PG, whereby gambling is used to escape from distress and stress associated with trauma, as well as dissociate (Nixon et al., 2013). The association with trauma in the current study is notable, given that all participants had recently returned from operational deployment, thus increasing the possibility of exposure to traumatic experiences. Rates of sub-threshold PTSD have been known to increase in personnel deployed to the MEAO (McFarlane, 2009). While levels of combat exposure across the overall sample were typically high, with many respondents in locations characterised by combat and other hazards exposure, individuals in the Army had the highest frequency of traumatic experiences during deployment (Davy et al., 2012). This is consistent with the typical roles of Army personnel in combat relative to other services. In part, this may account for why the sub-group of Army personnel in this study had the highest levels of gambling problems.

Certain psychopathology symptoms may increase risk-taking behaviour (McFarlane, 2009) and some types of gambling (e.g. sports betting) may reflect maladaptive strategies to increase mood in those with depressive or PTSD symptoms. Given that the MEAO population as a whole is known to demonstrate higher rates of depressive and PTSD symptoms, this is an important consideration (Davy et al, 2012). The current study was not able to consider different types of gambling behaviours and this highlights the need for further research into gambling types in military populations.

The results indicated additional correlates of sub-clinical gambling problems that were classified in terms of ARG. Relative to respondents reporting no problems, ARG was associated with increased likelihood of reporting probable PTSD, harmful drinking, fair to poor QOL, as well as high psychological distress. However, these differences were all relatively modest when compared to analogous associations with PG (significant effects ranged from OR = 2.0 to 2.5), while there were no significant links with depression and alcohol dependence (when

controlling for effects of covariates including age, rank and ADF service). These relatively modest associations are consistent with prior research in non-military samples (Cowlshaw and Kessler, 2016), and also support the view of ARG as an appropriate target for early intervention strategies that aim to prevent or avoid the most serious mental health consequences of gambling before they occur.

Finally, the results indicated associations between gambling problems and a range of post-deployment adjustment difficulties. Post-deployment is recognised as a challenging transition period for many military personnel (Forbes et al., 2019). However, we know of only one prior study of US military personnel and veterans which demonstrated associations with gambling problems and post-deployment stressors; the latter based on retrospective reports that were often provided many years after deployment (Whiting et al., 2016). In contrast, the current study considered contemporaneous experiences of specific adjustment difficulties post-deployment, and found that PG was associated with not wanting to talk about deployment experiences with family or friends, arguing more with intimate partners, and difficulties resuming normal social activities; these were all characterised by more than three-fold increases in rates among PGs. Furthermore, ARG was also associated with significant yet comparably modest increases (ORs = 1.5 to 1.8) in reports of feeling let down by people and difficulties adjusting to being home or resuming normal social activities. For several of these associations it seems likely that adjustment difficulties can precipitate or exacerbate problems with gambling. For example, gambling may be used to physically avoid discussions with family or friends, or may comprise a substitution for normal social activities and means of coping with difficulties being home. However, over time it is likely that gambling problems could increasingly exacerbate these difficulties (for example, through additional arguments with family members about gambling losses), and thus contribute towards the post-deployment adjustment problems of returned military personnel.

Strengths and limitations

The current study was characterised by notable strengths including high response rates, as well as a large sample size and usage of sophisticated missing data techniques which supported analyses of the entire sample at post-deployment (despite survey non-response). Furthermore, mental health conditions and addictive behaviours, including gambling problems, were measured using a range of validated scales with strong psychometric properties. Notwithstanding these strengths, however, the findings should still be viewed in the context of limitations.

Surveys did not include questions about the nature of gambling participation, and thus the types of activities that were implicated in problems (e.g., electronic gambling machines, online sports betting). Gambling problems were measured using the PGSI that does not provide a comprehensive assessment of problematic gambling behaviours or harms. The study also used an adapted version of this scale which referenced the period since beginning the last deployment. These deployments were typically in excess of six months and were likely characterised by restricted gambling opportunities given limited internet connectivity and land-based gambling venues in the MEAO. Accordingly, while the reference period for PGSI was probably around the past-year for many respondents, this varied across participants and only a proportion of this that was spent in a widely accessible gambling environment. The administration of the post-deployment survey at four months may be inadequate to accurately capture gambling problems as they develop over time. The study also used alternative cut-off criteria for the PGSI that may not compare with other studies (figures produced using the conventional scoring criteria for the PGSI can be found in **Appendix C**).

The analyses did not consider data regarding the nature and diversity of roles and deployment-related experiences. Measures of other mental health problems, including Depression and PTSD, adopted the conventional format for relevant scales which referenced past-month experiences, and thus different periods of observation when compared to the PGSI. Furthermore, the current study used cut-off criteria for identifying 'caseness' with these

scales which are commonly used in civilian settings, as opposed to alternative criteria which have been developed specifically for the ADF (Searle et al., 2015, Searle et al., 2017).

The analyses were based on cross-sectional data and do not provide evidence of processes that unfold over time, including the likely directionality of associations. As such, the causal precedence of gambling problems over mental health and wellbeing indicators, while assumed by regression analyses, cannot be established using this cross-sectional data. Consistent with other literature, these gambling problems and associated risk factors explored here are likely to mutually reinforce each other. Finally, the current analyses considered data around four months following an operational deployment, and do not indicate how issues might progress over a longer period post-deployment period. The findings might also have limited generalisability to other stages of typical ADF careers and transitions out of the military.

Implications and future directions

The findings suggest that gambling problems are salient concerns for some Australian military personnel in the post-deployment period, occur frequently relative to other mental health and alcohol use problems, and have potential implications for mental health, wellbeing, and post-deployment adjustment. They highlight the need for increased recognition and responses in military contexts, which should consider these addictive behaviours routinely alongside other conditions and issues including depression, PTSD and alcohol misuse.

Post-deployment psychological screening is mandatory among ADF personnel and is focussed largely on distress, PTSD, and alcohol use (O'Donnell et al., 2014), and these findings suggest that consideration should be given to either extending this to gambling, or else ensuring that health professionals administering screening interviews are alert to the possibility of gambling issues. Identification strategies should address gambling problems across a continuum of severity, including early stage or sub-clinical issues (ARG), as well as comparably severe levels of PG. Identification strategies may draw from validated measurement tools, including brief scales such as the three-item NODS-CLiP (Toce-Gerstein et al., 2009), which is only sensitive to PG (Cowlshaw et al., 2018), as well as longer measures (such as the nine-item PGSI) that may increase identification of both ARG and PG.

The ADF has incorporated mental health prevention as an arm of its current Mental Health and Wellbeing Strategy, and provides a number of education and health promotion programs regarding a range of mental health issues, including some attempts at increasing literacy surrounding gambling behaviours. These findings suggests that a strengthening of that approach for gambling problems is warranted, both within the ADF and for those who work with veterans.

Mental health service providers who work in military or veteran mental health settings should also be vigilant for gambling problems, both as a primary presenting problem and secondary issue underlying other concerns that may complicate treatment and recovery. At a minimum, there should be training and support for clinical staff in identification strategies and pathways to care. The latter may involve referrals to specialist gambling help services in Australia, which should also consider developing their military and veteran 'cultural competence'; for example, by increasing understanding of the deployment environment and common challenges following the transition out of military service. Low military cultural competence is a recognised barrier to military and veteran populations engaging with non-military health care providers, and recent efforts to educate civilian services about the unique features of military culture and demography have been encouraging (Forbes et al., 2019). However, it may also be that veteran-specific help services are suitably positioned and resourced to deliver gambling focused interventions. The latter may include intensive psychological therapies which have demonstrated efficacy for severe cases of PG (Cowlshaw et al., 2012), as well as behaviour change strategies (Rodda et al., 2018) that may be comparably brief and suitable for purposes of early intervention.

There is a strong need for research that can inform the development of gambling harm reduction initiatives in Australian military and veteran-specific contexts. In particular, there would be substantial value from future research into the implications of deployment related traumatic experiences on the development of gambling problems, especially in at-risk groups. This also includes future research on gambling problems among veterans during other major military career periods, such as the transition out of the ADF. Transition from the military has been identified as an important period of increased risk for mental health problems. While the 'healthy soldier effect' is thought to be protective against some mental health problems during military service, rates of common mental disorders among veterans double in the first five years of leaving the military, and become significantly greater than when compared to civilian populations (Van Hooff, 2018). The transition period is also characterised by heightened vulnerability to adjustment difficulties and risk-taking activities including alcohol and drug use (Van Hooff, 2018), which may extend to gambling problems. This possibility should be considered in future research.

There is also a need for additional research on the nature and extent of a broader range of gambling-related harms in military contexts, which may include financial, relationship, health-related (including psychological), workplace and legal domains (Langham et al., 2015), and may also involve substantial harms to others (Goodwin et al., 2017). Studies of non-military samples have indicated that gambling problems are associated with both suicide (Cowlshaw and Kessler, 2016) and violent behaviour (including Intimate Partner Violence) (Roberts et al., 2018), which are also major concerns in military and veteran populations (Bruce, 2010, Sullivan and Elbogen, 2014), and thus require focussed attention.

There are important opportunities for future research on the nature, feasibility and effects of gambling-focussed interventions which are suitable for military and veteran populations. These may include studies of novel psychological therapies for PG which are based on existing treatments (Cowlshaw et al., 2012), but are trauma-informed and otherwise adapted for veteran-specific contexts. These should also include studies of the development and effects behaviour change strategies (Rodda et al., 2018) that may be utilised in the context of 'low intensity' interventions that target ARG.

Finally, there is also a particular need for exploration of the gambling activities, experiences and environments of military and ex-service personnel, while on deployment and also in the context of the Australian community. By way of illustration, there are Ex-Service Organisations in Australia that offer social spaces which sometimes provide high-intensity EGMs, which are also shown to account for substantial harm at both the individual and community level (Markham et al., 2014). There is a clear need for research to improve understanding of the impacts of these gambling environments and cultures on military personnel and veterans, as well as how gambling preferences may be changing within and across different cohorts of personnel; for example, in response to the increased accessibility of online gambling and mobile sports betting, and potential moves away from land-based gambling venues.

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Appendices

Appendix A

Analyses of missing data and responders / non-responder analyses

Table A1 shows characteristics of the eligible population as well as pre-deployment responders and non-responders. As can be seen, there were N = 3074 ADF personnel who deployed to the MEAO during the data collection period, and n = 1871 completed pre-deployment questionnaires (response rate = 60.9 per cent). When compared to responders, non-responders were similarly distributed in terms of sex, age, and rank (with the majority of both being male, younger in age and comprising lower to mid ranks). However, responders were more likely to report service with the Air Force and were less likely to report service with the Army and Navy.

Table A1. Characteristics of the initial eligible population and pre-deployment responders versus non-responders

	Population	Pre-deployment responders		Pre-deployment non-responders	
	(N)	n	%	n	%
Total	3074	1871		1203	
Sex					
Male	2824	1699	90.8%	1125	93.5%
Female	250	172	9.2%	78	6.5%
Age, years					
16-24	1076	600	32.1%	476	39.6%
25-34	1270	785	42.0%	485	40.3%
35-44	543	348	18.6%	195	16.2%
45-55	160	119	6.4%	41	3.4%
55+	23	19	1.0%	< 5 [†]	NA
Service					
Navy	233	101	5.4%	132	11.0%
Army	2289	1322	70.7%	967	80.4%
Air Force	552	448	23.9%	104	8.6%
Rank					
Officer	467	311	16.6%	156	13.0%
NCO	1212	741	39.6%	471	39.2%
Other ranks	1395	819	43.8%	576	47.8%

NB: † = Small cell size suppressed.

The PGSI was only added to the pre-deployment surveys part-way through the data collection phase, and was thus unavailable for the entire sample. Accordingly, there were $n = 771$ survey respondents at pre-deployment that had data on the PGSI, which comprised 41.2 per cent of the baseline sample. Post-deployment surveys were returned by a total of $n = 1324$ respondents, which corresponds to 70.8 per cent of the pre-deployment sample (and 43.1 per cent of the initially eligible population).

Table 1 shows socio-demographic and service-related characteristics of the sample at pre-deployment and post-deployment, as well as pre-deployment subsample of participants that were administered the PGSI. As can be seen, across both pre-deployment and post-deployment periods, the respondents were predominately male, aged less than 40, and most were in married/de facto relationships. The majority of participants reported service with the Army, and with the ADF for less than 10 years.

Table A2. Comparisons across pre-deployment samples with and without the PGSI, and well as with the post-deployment sample

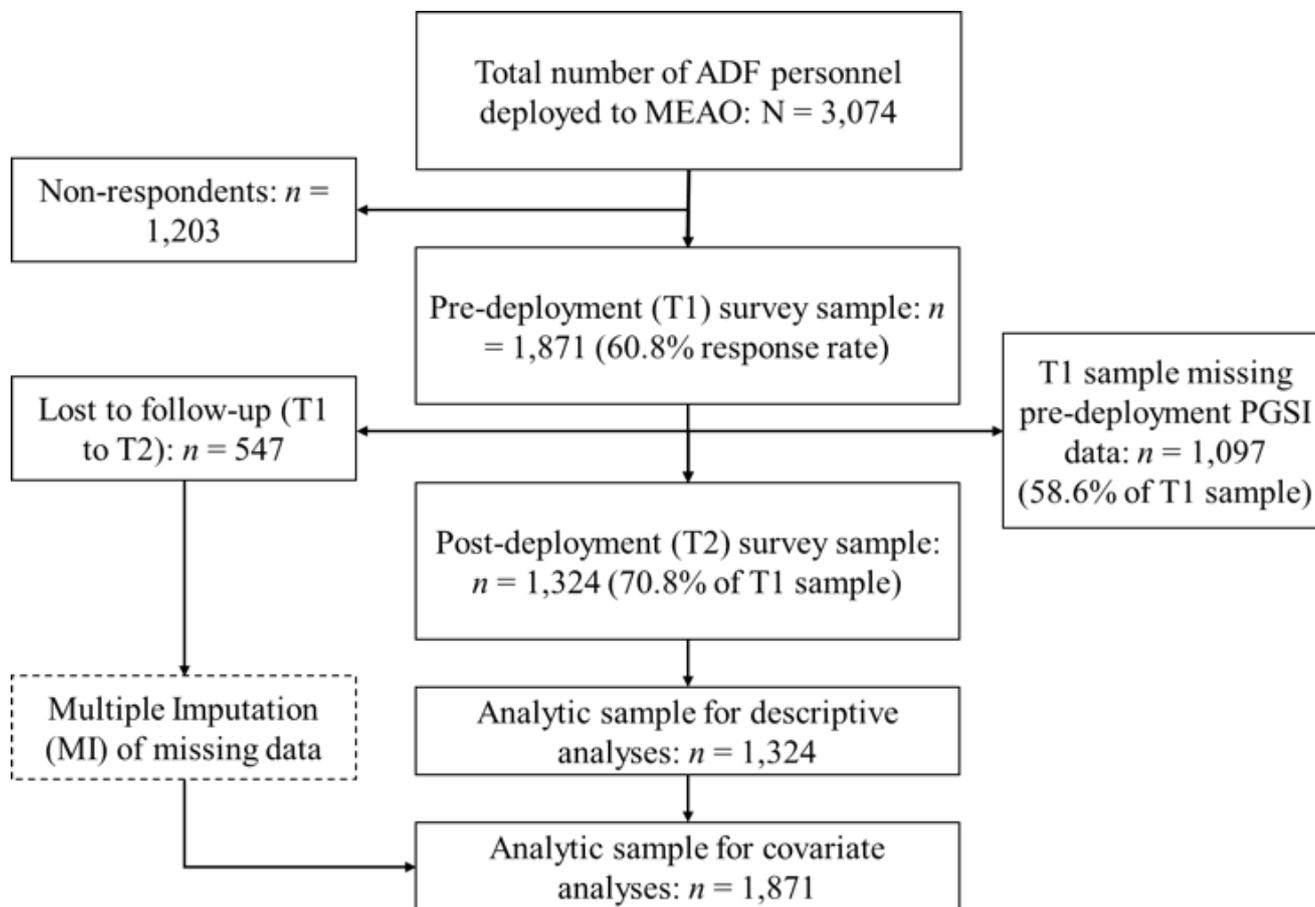
	Pre-deployment				Post-deployment	
	Total sample $n = 1871$		PGSI sample $n = 771$		$n = 1324$	
	n	%	n	%	n	%
Sex (male)	1699	90.8	730	94.7	1197	90.4
Age, years						
18–24	600	32.1	290	37.6	397	30.0
25–30	568	30.4	262	34.0	376	28.4
31–39	404	21.6	151	19.6	296	22.4
40+	299	16.0	68	8.8	255	19.3
Relationship status						
Married/de facto	1252	68.7	512	67.6	920	69.5
Single, never married	520	28.5	231	30.5	347	26.2
D/S/O	51	2.8	14	1.8	34	2.6
Education	1009	54.5	478	62.2	702	53.0
Service						
Army	1322	70.7	717	93.0	925	69.9
Navy	448	23.9	43	5.6	330	24.9
Air Force	101	5.4	11	1.4	69	5.2
Rank (NCO/other ranks)	1517	83.2	666	86.4	1053	79.5
Length of service (years)						
0–4	705	38.4	308	40.2	494	37.3
5–9	559	30.4	265	34.6	382	28.9
10–19	361	19.6	139	18.1	250	18.9
20+	213	11.6	55	7.2	183	13.8

In the context of substantial missing data on the PGSI at pre-deployment, a series of analyses were conducted to screen for systematic differences in survey respondents with and without these PGSI scores. The analyses comprised χ^2 -tests followed by logistic regression models for significant effects, which indicated a number of associations across socio-demographic and service-related characteristics. Most notably, ADF service was strongly related to the absence of gambling data, whereby members of the Navy and Air Force were more likely to be missing this information, compared to the Army (corresponding ORs were 11.2 and 9.7, respectively). This is presumably the result of variations across planned rotations and operational tempo, with Army having shorter and more frequent deployment cycles to the MEAO relative to the other services during the data collection period. Analyses also indicated relatively modest associations with missing data on the PGSI and additional characteristics which were unsurprising given findings for ADF service. For instance, there were higher levels of PGSI missing among participants who were older and had served longer in the ADF (e.g., participants aged > 40 years were 3.2 times more likely to report missing data on the PGSI when compared to those aged 18–24, while those with 20+ years of service were 2.6 times more likely when compared to those with 5–9 years of service), while females also reported higher levels of missing when compared to males (OR = 2.41). All other associations were modest (OR < 2.0). These associations are consistent with the typical demographic makeup of the Australian Army relative to the other services.

Comparable analyses, including preliminary χ^2 -tests followed by logistic regression models for significant effects, were also conducted to screen for systematic patterns of non-response at post-deployment across the same socio-demographic and service related characteristics. These indicated significant associations with post-deployment non-response and age and length of service, and in both instances the older and longer serving respondents were less likely to be lost to follow-up; for example, comparisons involving the oldest (versus youngest) and longest serving (versus shortest serving) respondents produced ORs of 0.34 and 0.39, respectively. There were also significant associations with rank (commissioned officers were less likely to be non-respondents when compared to more junior ranks) and relationship status (personnel in married/de facto relationships were less likely to be non-respondents when compared to those who were single or divorced/separated/other), although these effects were modest (ORs < 2.0).

Appendix B

Flow chart of study participants, non-responders and missing data



Appendix C

Gambling problem rates estimated using conventional PGSI cut-off criteria

Table 2. Gambling problem rates

	n	%	95% CI	
			n	%
Gambling problems (since beginning of last deployment)				
Non-problem gambling (PGSI = 0)	1166	88.1%	86.2%	89.7%
Low-risk gambling (PGSI = 1-2)	58	4.4%	3.4%	5.7%
Moderate-risk gambling (PGSI = 3-7)	35	2.6%	1.9%	3.7%
Problem gambling (PGSI ≥ 8)	9	0.7%	0.3%	1.3%

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