Effects of deployment on health behaviours in military forces: A review of longitudinal studies

Eva Pietrzak PhD, Stephen Pullman, Cristina Cotea, BSc (Hons.) Peter Nasveld, MBBS, FACTM

Abstract

Background: Earlier studies indicating that operational deployment affects health behaviours among military personnel and veterans generally lacked final conclusiveness due to cross-sectional or retrospective design.

Aim: The aim of this study is to review longitudinal studies investigating whether military service, in particular operational deployment, affects health behaviours, specifically alcohol misuse, smoking, eating disorders and obesity.

Methods: A MEDLINE database search was performed, using relevant keywords and MESH terms. The US Millennium Cohort study website was used to obtain the list of relevant publications. Only studies with prospective longitudinal cohort design, conducted on military or veteran populations of developed countries serving after the Vietnam War and investigating health behaviours and health markers such as excessive drinking, smoking, disordered eating and body weight were included.

Results: Six studies fulfilled the inclusion criteria, three that resulted from the US Millennium Cohort study and three that investigated other military populations.

Deployment with combat exposure was the most significant factor affecting health behaviours of military personnel.

Excessive drinking among US military personnel increased significantly in those deployed that were exposed to combat, especially among Reserve and National Guard members and in the youngest age groups, but was not affected by deployment without combat exposure. Among British military personnel, total alcohol consumption increased with time, was higher for those deployed compared to non-deployed, and highest in those who experienced war related stress.

Smoking in the US military increased among those deployed, particularly among those with prolonged and multiple deployments or with combat exposure. Among British military personnel, smoking rates declined.

Body weight increased for the majority of US military personnel, but disordered eating was reported only among deployed women with combat exposure. An increase in body weight was also reported in the Belgian military.

Conclusions: Generally, it was combat exposure, not deployment in general, that had affected health behaviours. As hazardous health behaviours may affect negatively on physical readiness and re-deployability of military personnel, preventive measures should concentrate on those subgroups that are most vulnerable.

Keywords: Military personnel, veterans, deployment, longitudinal study, health behaviours

Acknowledgements: This review was undertaken on behalf of the Longitudinal Health Surveillance Program, UQ Node, CMVH.

Conflict of interest: The authors declare no conflict of interest

Introduction

Recent studies present compelling evidence that military deployment with combat exposure negatively affects the mental health of deployed personnel, especially the incidence of post-traumatic stress disorder (PTSD)[1]. There is also a strong indication that combat exposure affects health behaviours [2, 3], which will in turn affect physical readiness, health and health care needs in the future.

Alcohol abuse, increased smoking and disordered

eating often serve as maladaptive coping mechanisms after traumatic events. Alcohol abuse is highly correlated with PTSD and other psychological disorders that may occur after stressful and traumatic events, such as those associated with war[2, 3]. The rate of heavy drinking is estimated at 20% in the general US military population, but can be as high as 30% among younger groups (aged 18 – 25 years old) [4]. Recent cross-sectional studies report an increased rate of excessive drinking and associated disorders in those returning from deployment[1].

The excessive use of alcohol has many implications on public health. Globally, nearly 4% of all deaths are related to excessive alcohol consumption, and can reach 9% among younger groups (aged 15-29 years old). Most alcohol-related deaths result from injuries, cancer, cardiovascular diseases and liver cirrhosis[5]. The family and social consequences of excessive drinking are also extensive[6].

Cross-sectional studies found increased post-deployment smoking rates among previous non smokers and increased daily cigarette intake among smokers[7]. This finding is important as smoking is the leading preventable cause of death and the long-term damaging health consequences associated with this health behaviour are well established[8, 9]. In the US, more than 400,000 people die each year due to smoking, with $167 billion spent in annual health-related economic losses[10]. In Australia, smoking was the single risk factor responsible for the greatest disease burden, around 12% of the total burden in Australian males. Alcohol use, physical inactivity and obesity are responsible for a further 6.6%, 6% and 4% of the burden of disease, respectively[11].

Although these data relate to the civilian, not military Australian populations, they emphasise the importance of health behaviours in determining physical readiness, re-deployability and future health care needs in the military and veteran populations.

Epidemiological studies show an increasing rate of obesity among whole populations including young people[12]. The obesity epidemic has serious implications for recruitment and retention of Defence Force personnel[13] and places an additional strain on the health care needs of veterans and their families[14].

Recently, an increasing number of Australian Defence Force members have been involved in multiple deployments, with Australian troops taking part in conflicts in Iraq and Afghanistan and playing a significant peacekeeping role in the Pacific region. Consequently, increasing emphasis has been placed on investigating the effects of these deployments on the health of military personnel. Military forces have certain health and fitness standards aimed at selecting and maintaining individuals that are best suited to the physical demands of military service. Any knowledge regarding the effects of military deployment and military specific exposures could therefore allow for better preparation for the ensuing consequences of deployment.

A systematic review of prospective longitudinal cohort studies performed in the military was undertaken to investigate the often raised question of whether military service, in particular operational deployment, results in a higher risk of chronic illness among military personnel and veterans. This wider review, performed for the Centre for Military and Veterans' Health investigated mental[15] and physical health outcomes.

The aim of this study is to review longitudinal studies investigating whether military service, in particular operational deployment, affects health behaviours, specifically alcohol misuse, smoking, eating disorders and obesity.

Methods

The MEDLINE database was searched using relevant keywords and MESH terms. Three separate searches were performed. In search 1, the relevant studies were retrieved from the US Millennium Cohort study website. Search 2 combined terms: Military Personnel (MESH), longitudinal study (MESH and keyword) and Health (MESH and keyword). Search 3 combined terms: Veterans(MESH), longitudinal study (MESH and keyword) and Health (MESH and keyword). The terms of the search were purposely broad and not restricted by the outcome, due to the search being performed for a wider CMVH review, which also investigated mental[15] and physical health outcomes. The references were downloaded to an EndNote library and duplicates were removed. The search was performed in July 2010.

Study design. Only longitudinal prospective cohort studies were included. Retrospective longitudinal studies and longitudinal panel studies were excluded. There are distinct benefits of prospective longitudinal cohort studies over cross-sectional and retrospective studies. Prospective longitudinal studies can distinguish between short-term and long-term phenomena, contribute to establishing causative associations between exposure and outcome, and minimise recall and selection biases that are often influenced by exposure and/or health outcome.

Outcomes. To be included in the present review, the studies had to investigate health behaviours such as alcohol drinking, smoking, disturbed eating patterns

and health markers such as body weight in military or veteran populations.

Cohorts. At inception, the included cohort had to be in active military service after the Vietnam War.

The references were assessed for relevance, based on the examination of titles and abstracts. The flow of citations examined in the course of this review has been presented in Figure 1.

The quality of the studies was assessed using study design checklists based on recommendations by Sanderson et al. for the appraisal of observational studies.[16] Quality criteria included cohort size, sample selection, follow-up rate and duration, outcome and exposure measurement bias, type of analysis, clarity of the results and adjustment for confounders. Each of the seven appraisal questions was assigned a score of 2 and 0 for "YES" and "NO" answers and 1 point for "Can't tell or mixed answer". Only cohorts above 1000 participants were assigned points for the size. The maximum number of points in the appraisal score was 14. Studies with scores of 13-14, 10-12 and 7-9 were considered to be, respectively, of very good, good and moderate quality, and those below 7 points, of low quality.

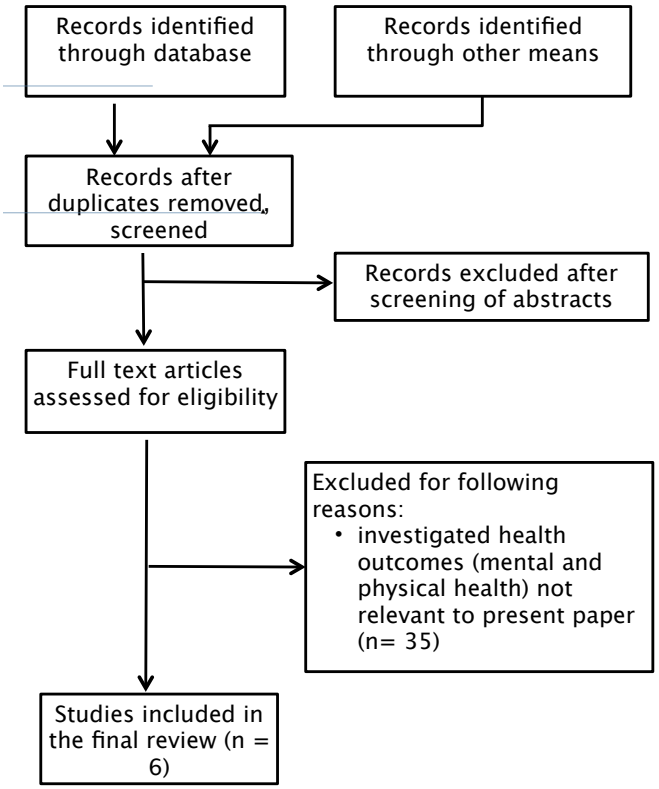
Results

There were 6 studies that fulfilled the inclusion criteria. Four studies investigated drinking and smoking behaviour,[17-20] and 2 studies investigated body weight and disturbed eating patterns.[21, 22] Three studies resulted from the US Millennium Cohort study[17, 18, 21] and three studies investigated other military populations.[19, 20, 22]

The main results of the included papers are presented in the text below. Additional details are presented in Table 1.

The Jacobson et al. (2008) US Millenium Cohort study investigated whether deployment with combat exposures was associated with changes in drinking behaviour.[17] Drinking was estimated at baseline and follow-up from the number of drinks consumed on each day of the week before completing the questionnaire. Heavy drinking for men was defined as more than 14 drinks consumed per week and binge drinking as 5 or more drinks consumed per drinking occasion; for women 7 drinks per week constituted heavy drinking and 4 per drinking occasion, binge drinking. The rates of new-onset of heavy weekly drinking, binge drinking and alcohol-related problems were compared between deployed with and without combat exposures and non-deployed personnel. The comparisons were performed separately for Reserve, National Guard and active duty personnel. There

Figure 1. The flow of citations reviewed in the course of this review.



were no differences between drinking behaviour of those deployed without combat exposure and non-deployed. Significant increases of new onset for all three outcomes of drinking behaviour was seen in deployed with combat exposure compared to non-deployed. However, these outcomes differed between service components. Combat exposed members of Reserve and National Guard members showed increases on all three measures, while for active duty personnel, only binge drinking was increased. The youngest members of the cohort (those born in 1980 and later) were at the highest risk for all alcohol-related outcomes compared with more mature age groups. These findings suggest that Reserve and National Guard personnel and younger service members who deploy with reported combat exposures are at increased risk of new-onset heavy weekly drinking, binge drinking, and alcohol-related problems.

The Smith et al. (2008) US Millenium Cohort study investigated three measures of smoking behaviour, namely new smoking among never-smokers, smoking recidivism among past smokers and change in daily smoking among smokers in relation to military deployment.[18] The rates of all three measures increased in those deployed compared to non-deployed. Among those deployed, those with

Table 1. Summary of characteristcs and results of included studies

Study	Study characteristics	Results
Excessive drinking and smoking		
Jacobson 2008[17] US Millennium cohort	N=48,481 OBJECTIVE: To determine whether deployment with combat exposures was associated with new-onset problem drinking. POPULATION: There were 26,613 participants on active duty, and 21,868 in Reserve or National Guard. Of these, 5510 deployed with combat exposures, 5661 deployed without combat exposures, and 37 310 did not deploy. Follow-up rate 71%, duration ~3 years OUTCOMES: New-onset and continued heavy weekly drinking binge drinking, and alcohol-related problems at follow-up. ANALYSIS: Multivariable logistic regressions. Appraisal Quality Score (AQS)=13	New-onset rates of heavy weekly drinking, binge drinking, and alcohol-related problems were: 8.8%, 25.6%, and 7.1% among Reserve or National Guard who deployed and had combat exposure; and 6.0%, 26.6%, and 4.8% among active-duty personnel. Significant increases of new onset weekly drinking, binge drinking, and alcohol-related problems were seen among Reserve and National Guard, with odds ratios of 1.63 (95% CI 1.36-1.96), 1.46 (1.24-1.71) and 1.63 (1.33-2.01), respectively. For active duty personnel, only binge drinking was significantly increased 1.46 (1.24-1.71). The youngest members of the cohort (those born in 1980 and later) were at highest risk for all alcohol-related outcomes, with odds ratios of 2.41, 6.72 and 4.67, respectively, for National Guard and Reserve and 3.74, 6.90 and 4.82 for active duty personnel, when compared with the reference age group of those born in 1960 or earlier. CONCLUSION: Reserve and National Guard personnel and younger service members who deploy with reported combat exposures are at increased risk of new-onset heavy weekly drinking, binge drinking, and alcohol-related problems.
Smith 2008[18] US Millennium cohort	N=48,304 OBJECTIVE: To investigate smoking as a maladaptive coping behaviour in relation to military deployment. POPULATION: There were 36,770 non-deployed, 8489 deployed once and 3045 deployed multiple times. Follow-up rate 71% OUTCOMES: New smoking among never-smokers, smoking recidivism among past smokers, and change in daily smoking among smokers ANALYSIS: Multivariable logistic regressions. AQS=13	Among never-smokers, smoking initiation was identified in 1.3% of non-deployers and 2.3% of deployers. Among past smokers, smoking resumption occurred in 28.7% of non-deployers and 39.4% of those who deployed. Smoking increased 44% among non-deployers and 57% among deployers. Those who deployed and reported combat exposures were at 1.6 times greater risk of initiating smoking among baseline never-smokers and at 1.3 times greater odds of resuming smoking among baseline past smokers when compared to those who did not report combat exposures. Other deployment factors independently associated with post-deployment smoking recidivism included deploying for >9 months and deploying multiple times. Among those who smoked at baseline, deployment was not associated with changes in daily amount smoked. CONCLUSIONS: Military deployment is associated with smoking initiation and, more strongly, with smoking recidivism, particularly among those with prolonged deployments, multiple deployments, or combat exposures. Prevention programs should focus on the prevention of smoking relapse during or after deployment.

Hooper 2008[19] UK	N=941 OBJECTIVE: To investigate whether alcohol use and smoking is affected by deployment and combat exposure. POPULATION: a random sample of each Service of the UK Armed Forces; 1382 people surveyed at baseline in 2002, and 941 followed up around three years later. 330 were deployed to Iraq, 106 deployed elsewhere, 505 non-deployed. Follow-up rate 68%, duration at least 1 year. OUTCOMES: Alcohol and cigarette use were assessed on both occasions, and deployment to Iraq combat exposures during this time at FU. ANALYSIS: linear and logistic multiple regressions. AQS=9	There was no evidence that deployment and combat exposures were associated with a change in number of cigarettes smoked. Cigarette smoking declined during the three years of the study. The increase in alcohol consumption was greater in those who were deployed (p=.043), compared to non-deployed, but there were not significant differences between the deployment groups. The increase in alcohol consumption was greater in those subjects who had been deployed, in particular in those who thought they might be killed (p= 0.01), or who experienced hostility from civilians while on deployment (p= 0.01). The effects of these combat exposures were strongest in those most recently deployed. CONCLUSIONS: Overall, alcohol use in the UK military increased over time but cigarette use fell. Alcohol use increased following traumatic exposures, though this increase was not maintained over time. Heavy drinking persists in the Services, and the experiences of deployment may make some contribution to this.
Hemmingsson 2008[20] Sweden	N=694 OBJECTIVE: To determine the direction of causality: whether improved mental well-being results from smoking cessation; or those with poorer mental well-being are less successful at smoking cessation. POPULATION: A subgroup of 50,000 Swedish conscripts, age 18, surveyed in 1969 that participated subsequently in one or more annual national Swedish Surveys of Living Conditions in 1981–2001. Follow-up rate 80%. OUTCOMES: Smoking status ANALYSIS: Prevalence ratios with 95%CI. AQS=8	Smoking status was defined by smoking habits at conscription and FU. Individuals were divided into never smokers; late smokers (not at conscription, but smoking on follow up); quitters and persistent smokers. The last group was further divided into light and heavy smokers (fewer and more than 10 cigarettes/day, respectively). Approximately half of the smokers at age 18 in 1969 had quit by the time they were resurveyed (1981-2002). Persistent heavy smokers were more likely to have indicators of poor mental health measured at age 18 in 1969 than non-smokers or quitters. Men who would subsequently be successful at smoking cessation reported better mental health and a lower prevalence of childhood mental health indicators at age 18 than persistent heavy smokers. CONCLUSION: Mental health at young age affects smoking status at middle age.
Body weight		
Jacobson 2009[21] US Millennium cohort	N=48,378 OBJECTIVE: To investigate association between new-onset disordered eating and weight changes and deployment. POPULATION: Sample was stratified by sex and deployment status as follows. Total N: 12,641 female, 33,578 male, deployed without combat exposures: 1,085 F, 4,351M, Deployed with combat exposures: 870F, 4,397M. Follow-up rate 71%. OUTCOMES: disordered eating, changes in body weight (moderate 3-10%, extreme >10%). ANALYSIS: Multivariable logistic regressions. AQS=13	Deployment was not significantly associated with new-onset disordered eating in women or men, after adjustment for baseline demographic, military, and behavioural characteristics. However, in subgroup comparison analyses of deployers, deployed women reporting combat exposures were 1.78 times more likely to report new-onset disordered eating (95% CI: 1.02, 3.11) and 2.35 times more likely to lose 10% or more of their body weight compared with deployed women without combat exposures (95% CI: 1.17, 4.70). CONCLUSION: Among deployed women, combat exposures but not deployment itself represent a risk factor for developing eating problems and weight loss.

Mullie 2009[22] Belgium	N=1497 (longitudinal paired cohort), N=43,343 (longitudinal panel). OBJECTIVE: To evaluate body weight changes over 14 years POPULATION: Belgium army men, paired cohort identified from records. Participants took part in at least one peacekeeper mission. OUTCOMES: Body mass index (BMI) in each age category ANALYSIS: adjusted for military ranking system, used as an indicator for socio-economic status. AQS=8	A significant increase of BMI between age categories was detected over the 14-year period; BMI remained stable in each age category. In the paired cohort, median BMI increased during the same period from 23.9 kg/m2 to 24.7 kg/m2 (P < 0.0001). This age-dependent evolution was present in all military rankings. From age 40 years or more, BMI indicated a significant increase in the prevalence of overweight and obesity. CONCLUSION: For the total cohort, BMI remained stable in each age category. For the paired cohort, BMI increased over time. Practical implication: This emphasis on prevention of obesity should target those aged less than 40 years.

combat exposures were at greater risk of initiating or resuming smoking compared to those without combat exposures. Deployment longer than 9 months and multiple deployments were independently associated with post-deployment smoking recidivism. Among those who smoked at baseline, deployment was not associated with changes in daily amount smoked.

Drinking and smoking behaviour in relation to deployment was also investigated in a study of almost 1000 British military personnel[19] Cigarette smoking declined during the three years of the study for the total sample and there was no evidence that deployment and combat exposures were associated with a change in the number of cigarettes smoked. However, there was an increase in total alcohol consumption and in the prevalence of binge drinking. Binge drinking in the UK study[19] was defined as 7 or more drinks per occasion, twice per week, and 5 or more drinks per occasion once per week in the US study.[17] The increase in both outcomes was greater in those deployed compared to non-deployed, in particular in those who thought they might be killed or who experienced hostility from civilians and were most recently deployed.

In the study of about 700 Swedish military conscripts followed up for 30 years of civilian life, mental health at young age was predictive of smoking status at middle age 20. In particular, smoking cessation at 30–50 years of age was associated with indicators of mental well-being measured at 18 years of age. Approximately half of the young smokers had quit by the time they were resurveyed in middle age. Persistent heavy smokers were more likely to have indicators of poor mental health measured at a young age than non-smokers or quitters. Men who would subsequently be successful at smoking cessation reported better mental health and a lower prevalence of childhood mental health indicators at age 18 than persistent heavy smokers.

Disordered eating and changes in body weight were investigated in male and female participants of the Millennium Cohort study.[21] Deployment was not significantly associated with new-onset disordered eating in women or men. Among those deployed, women reporting combat exposures were more likely to report new-onset disordered eating or to lose 10% or more of their body weight compared with deployed women without combat exposures. Among deployed women, combat exposures but not deployment itself represents a risk factor for developing eating problems and weight loss.

In Belgium peacekeepers followed for 14 years, median BMI increased by about 1 BMI unit (kg/m2), and there was an increase in the prevalence of excessive body weight and obesity from age 40 years or more.[22]

All of the included studies were of adequate quality, with three US Millennium Cohort studies evaluated as very high quality (see Table 1).

Discussion

Excessive alcohol use has been a problem for many members of the Defence Forces over the years. Cross-sectional studies in the US and the UK have shown that baseline levels of drinking in the Armed Forces were higher than in the general population 23, 24. Increased alcohol use has been suggested as one possible explanation for previously unexplained increases in injury mortality subsequent to deployment 25. The Jacobson study found a significantly increased risk for new-onset heavy weekly drinking, binge drinking, and other alcohol related problems among Reserve/ Guard personnel deployed with reported combat exposures compared with non-deployed Reserve/Guard personnel. Interestingly, in the active duty personnel, only binge drinking was significantly increased. As a

possible explanation for this discrepancy, authors cite inadequate training and preparation of civilian soldiers for the added stresses of combat exposures faced during deployment; increased stress among individuals and their families having to transition between military and civilian occupational settings; military unit cohesiveness; and reduced access to support services, including family services, health and physical fitness programs, and ongoing prevention programs in civilian communities.[17] These explanations are in agreement with results of cross-sectional study that assessed the occupational factors and deployment experiences associated with heavy drinking in regular UK servicemen deployed to Iraq.[26] Personnel whose role in theatre was outside their training or experience, and who experienced poor in-theatre unit leadership were more likely to be heavy drinkers. The results of the Jacobson study[17] clearly indicate that it was combat exposure, not a deployment itself that resulted in the increased alcohol use among US troops.

Among UK military personnel,[19] the total alcohol consumption was greater in those deployed compared to non-deployed. Although there were methodological differences in the criteria for assessing binge drinking, in agreement with the results of the US Millennium cohort study, the greatest increase of drinking was seen among those exposed to war-related stress.

It is unclear whether these patterns of drinking will continue in the future. These questions will be answered when the US Millennium cohort study publishes the results of the third wave of assessments. However, it can be speculated that the patterns of drinking will be inter-related with post-deployment experiences and personal susceptibilities to the disorder. Such a finding was reported in a review of retrospective studies of alcohol use in the UK Armed Forces, where heavy drinking was associated not only with deployment stress (being deployed to Bosnia), but also with family circumstances (being unmarried/separated/divorced) and personal characteristics (poorer subjective physical and mental health).[27] The findings of all studies on alcohol imply that preventive measures should concentrate on those subgroups that are most vulnerable to adverse health behaviours.

In the US, the smoking rate among military personnel is much higher than in the civilian population. In 2005, the rate of smoking among military personnel was 32% compared to 21% in the civilian population, and the rate was found to be increasing in recent years.[28] The increasing rates are explained by recent findings of the US Millennium Cohort study showing that deployment is associated with smoking initiation and, more strongly, with smoking recidivism, particularly among those with prolonged deployments, multiple deployments, or combat exposures.[18]

Recent smoking trends among the UK military were different from those observed in the US forces. The Hooper study 19 showed that smoking was less prevalent in the UK Armed Forces than in the general population. Additionally, cigarette smoking rates declined during the three years of the study and there was no evidence that deployment and combat exposures were associated with a change in the number of cigarettes smoked. This was unexpected, as lower ranks are recruited from lower socioeconomic groups, and a military environment has been thought to encourage smoking.[29] The differences in smoking behaviours in UK and US military forces may be related to cultural differences between the countries and to differences in the terms of deployment. In the US, the antismoking campaign is undermined by a pricing policy that allows discounted tobacco products to be sold in the military commissaries.[30] The standard US Army deployment to Iraq and Afghanistan is longer than the comparable UK deployment, 12 and 6 months "boots on the ground", respectively.[31, 32] The rates of PTSD among US deployed personnel[33] are higher compared to UK deployed personnel.[34] As smoking behaviour is co-morbid with PTSD, it may result in a decreased need for this maladaptive coping behaviour among UK military personnel compared to US military.

Civilian studies indicated that smoking behaviour was found to be related to mental well-being and personality traits. In Swedish conscripts followed up for 30 years of civilian life, mental health at a young age was predictive of smoking status at middle age.[20] Although all participants in this study started up as military conscripts, after finishing their 2-year long military service they exited to the civilian life for the rest of the follow up period. In the New Zealand Dunedin birth cohort followed up for 24 years, negative emotionality and personality trends, such as higher aggression and alienation measured at earlier age predicted smoking at later assessment, while higher self-control and traditionalism predicted non-smoking later.[35] It should be noted that it is only by inference that we assume that psychological factors that affect behaviour are similar in both civilian and military populations.

The US Millennium cohort study[21] did not find disordered eating or changes in body weight in the general population of deployed women or men. However, women exposed to combat were more likely to report new-onset disordered eating or to lose a significant amount of weight compared to deployed

women without combat exposures. Among deployed women, combat exposures but nor deployment itself represents a risk factor for developing eating problems and weight loss. As these findings do not apply to the male group of US military personnel, it appears that disordered eating and changes in body weight are generally more common among female military personnel. This study is in an agreement with civilian studies that report a higher proportion of eating disorders in women compared to men. Based on the US National Survey sample of over 9000 adults, lifetime prevalence estimates of anorexia nervosa, bulimia nervosa, and binge eating disorder are 0.9%, 1.5% and 3.5% among women, and 0.3%, 0.5% and 2.0% among men[36] While anorexia and bulimia are 3 times less frequent in men, binge eating is not only more prevalent for both sexes but the rate of overeating among men is comparable to the rate among women.

The US Millennium cohort study of Jacobson et al. (2009)[21] uses self-reported data on weight and height. Other studies have shown that the overweight but otherwise healthy survey participants have a tendency to slightly overestimate their height and underestimate their weight.[37, 38] Participants with an eating disorder appear to be more accurate in reporting their weight,[39,40] but still have a tendency to minimise their weight problems. Thus, the use of self-reported data in the Jacobson et al. (2009) study could potentially skew the data toward slight under-reporting of the problem rather then over-reporting; however, in such a large sample it should not significantly affect evaluation of changes over time in the development of new-onset disordered eating.

In the whole sample of the US Millennium Cohort study,[21] the average weight gain in men and women between the baseline and follow-up was 2.1 kg and 2.7 kg, respectively, which represents a 2.6% increase among men and a 4.1% increase among women. Only approximately 33% of women and 48% of men reported maintaining a stable weight between baseline and follow-up, regardless of deployment status. It is not clear whether this trend will continue at the present pace. For example, in male Belgian military personnel, who were deployed to at least one peacekeeper mission, the median body weight increased at a much slower rate, by about 1 BMI unit (kg/m2) in total during the 14 years of follow up.[22] This is in agreement with comparative data on international obesity rates, which indicate there is a much higher proportion of obese adults in the US, the UK and Australia compared to continental Europe (US: 30.6%, UK: 23%, Australia: 21.7%, Belgium: 11.7% in 2002).[41] As obesity is a known risk for many diseases, the strain on healthcare in the military may increase in parallel to that observed in the general population.

A recent systematic review of obesity in military populations found a general lack of information available to address the issues of obesity and subsequent health in military personnel, obesity status and work performance (absenteeism and discharge), and obesity status and physical performance.[13] The authors concluded that it is not currently possible to report on the implications of obesity for recruitment, training and workforce maintenance in the military. The limited available data suggested that excessive body weight and obesity per se are not necessarily reasons for preclusion from military service, but efforts are required to evaluate the extent of the current and future risk for chronic obesity-related disease and to assess physical fitness.[13]

Limitations of the review

This review is limited by the low number of longitudinal studies investigating health behaviours in the military. Although results and conclusions drawn from the US Millennium Cohort studies represent a high level of evidence, the study is ongoing and the long term effects from the third wave of assessments are yet to be published. Additionally, direct generalisation of results from the US Millennium Cohort to military populations of other countries may be limited by cultural and national differences and different terms of deployment.

Key points/Summary conclusions

The key finding from these studies was that it was combat exposure, not deployment in general that was the most significant factor affecting health behaviours of military personnel.

Alcohol drinking did not increase in the whole sample of deployed US military personnel, but drinking increased in those with combat exposure, especially among Reserve and National Guard and the youngest age groups. Among British military personnel, alcohol consumption increased in those deployed compared to non-deployed, especially among those who experienced war related stress.

Smoking was significantly increased by deployment, particularly prolonged deployments or multiple deployments and combat exposures in the US military, but not in the British military, where smoking declined with time.

A trend towards increased body weight was seen in the US and Belgian military, but disordered eating was seen only among deployed women with combat exposure.

Hazardous health behaviours may have a negative effect on physical readiness and re-deployability of military personnel and increase future health care needs in the military and veteran populations.

Preventive measures should concentrate on those subgroups that are most vulnerable to adverse health behaviours, especially those that were exposed to combat.

Authors' affiliations: Centre for Military and Veterans' Health, University of Queensland, Qld, Australia
Corresponding author: Stephen Pullman, Centre for Military and Veterans' Health, Research Coordination Unit, The University of Queensland, Mayne Medical School, Herston Road, Herston QLD Australia 4006
Email: s.pullman@uq.edu.au

References

1. Milliken CS, Auchterlonie JL, Hoge CW. Longitudinal assessment of mental health problems among active and reserve component soldiers returning from the Iraq war. JAMA, 2007, 298(18): 2141-2148.
2. McFarlane AC. Epidemiological evidence about the relationship between PTSD and alcohol abuse: the nature of the association. Addictive Behaviors, 1998, 23(6): 813-825.
3. Shipherd JC, Stafford J, Tanner LR. Predicting alcohol and drug abuse in Persian Gulf War veterans: what role do PTSD symptoms play? Addictive Behaviors, 2005, 30(3): 595-599.
4. Bray RM, Hourani LL. Substance use trends among active duty military personnel: findings from the United States Department of Defense Health Related Behavior Surveys, 1980-2005. Addiction, 2007, 102(7): 1092-1101.
5. WHO. Global status report on alcohol and health 2011; Available from: http://www.who.int/substance_abuse/publications/global_alcohol_report/msbgsruprofiles.pdf.
6. Klingemann H, Gmel G, editors. Mapping the social consequences of alcohol consumption: WHO Regional Office for Europe/Kluwer Academic, Dordrecht; 2001.
7. Boos CJ, Croft AM. Smoking rates in the staff of a military field hospital before and after wartime deployment. J R Soc Med, 2004, 97(1): 20-22.
8. Doll R, Hill A. The mortality of doctors in relation to their smoking habits. BMJ, 1954, 1(4877): 1451-1455.
9. Sasco AJ, Secretan MB, Straif K. Tobacco smoking and cancer: a brief review of recent epidemiological evidence. Lung Cancer, 2004, 45 Suppl 2: S3-9.
10. Armour B, Woollery T, Malarcher A, et al. Annual smoking-attributable mortality, years of potential life lost, and productivity losses—United States, 1997–2001. MMWR Morb Mortal Wkly Rep, 2005, 54: 625-628.
11. Mathers CD, Vos ET, Stevenson CE, et al. The burden of disease and injury in Australia. Bulletin of the World Health Organization, 2001, 79: 1076-1084.
12. Guh DP, Zhang W, Bansback N, et al. The incidence of co-morbidities related to obesity and overweight: a systematic review and meta-analysis. BMC Public Health, 2009, 9: 88.
13. McLaughlin R, Wittert G. The obesity epidemic: implications for recruitment and retention of defence force personnel. Obes Rev, 2009, 10(6): 693-699.
14. Kress AM, Hartzel MC, Peterson MR. Burden of disease associated with overweight and obesity among U.S. military retirees and their dependents, aged 38-64, 2003. Prev Med, 2005, 41(1): 63-69.
15. Pietrzak E, Pullman S, Cotea C, et al. Effects of deployment on mental health in modern military forces: A review of longitudinal studies. JMVH, 2012, (in press).
16. Sanderson S, Tatt ID, Higgins JP. Tools for assessing quality and susceptibility to bias in observational studies in epidemiology: a systematic review and annotated bibliography. Int J Epidemiol, 2007, 36(3): 666-676.
17 Jacobson IG, Ryan MAK, Hooper TI, et al. Alcohol use and alcohol-related problems before and after military combat deployment. JAMA, 2008, 300(6): 663-675.
18. Smith B, Ryan MAK, Wingard DL, et al. Cigarette smoking and military deployment: a prospective evaluation. Am J Prev Med, 2008, 35(6): 539-546.
19. Hooper R, Rona RJ, Jones M, et al. Cigarette and alcohol use in the UK Armed Forces, and their association with combat exposures: a prospective study. Addictive Behaviors, 2008, 33(8): 1067-1071.

20. Hemmingsson T, Kriebel D, Tynelius P, et al. Adolescent mental health predicts quitting smoking in adulthood: a longitudinal analysis. Eur J Public Health, 2008, 18(1): 66-70.
21. Jacobson IG, Smith TC, Smith B, et al. Disordered eating and weight changes after deployment: longitudinal assessment of a large US military cohort. Am J Epidemiol, 2009, 169(4): 415-427.
22. Mullie P, Vansant G, Guelinckx I, et al. Trends in the evolution of BMI in Belgian army men. Public Health Nutrition, 2009, 12(7): 917-921.
23. Bray RM, Hourani LL, Rae Olmsted KL, et al. Department of Defense survey of health related behaviours among active duty military personnel http://www.ha.osd.mil/special_reports/2005_Health_Behaviors_Survey_1-07.pdf. 2006.
24. Fear NT, Iversen A, Meltzer H, et al. Patterns of drinking in the UK Armed Forces. Addiction, 2007, 102(11): 1749-1759.
25. Bell NS, Amoroso PJ, Wegman DH, et al. Proposed explanations for excess injury among veterans of the Persian Gulf War and a call for greater attention from policymakers and researchers. Inj Prev, 2001, 7(1): 4-9.
26. Browne T, Iversen A, Hull L, et al. How do experiences in Iraq affect alcohol use among male UK armed forces personnel? Occup Environ Med, 2008, 65(9): 628-633.
27. Iversen A, Waterdrinker A, Fear N, et al. Factors associated with heavy alcohol consumption in the U.K. armed forces: data from a health survey of Gulf, Bosnia, and era veterans. Mil Med, 2007, 172(9): 956-961.
28. Smith EA, Malone RE. " Everywhere the Soldier Will Be": Wartime Tobacco Promotion in the US Military. Am J Public Health, 2009, 99(9): 1595-1602.
29. Schei E, Sogaard J. The impact of military service on young men's smoking behavior. Prev Med, 1994, 23(2): 242-248.
30. Smith EA, Blackman VS, Malone RE. Death at a discount: how the tobacco industry thwarted tobacco control policies in US military commissaries. Tob Control, 2007, 16(1): 38-46.
31. http://usmilitary.about.com/od/armyjoin/a/deployment.htm.
32. Fear NT, Jones M, Murphy D, et al. What are the consequences of deployment to Iraq and Afghanistan on the mental health of the UK armed forces? A cohort study. The Lancet, 2010, 375(9728): 1783-1797.
33. Richardson LK, Frueh BC, Acierno R. Prevalence estimates of combat-related post-traumatic stress disorder: critical review. Aust N Z J Psychiatry, 2010, 44(1): 4-19.
34. Jones M, Rona R, Hooper R, et al. The burden of psychological symptoms in UK Armed Forces. Occup Med 2006, 56(5): 322.
35. Welch D, Poulton R. Personality influences on change in smoking behavior. Health Psychol, 2009, 28(3): 292-299.
36. Hudson JI, Hiripi E, Pope Jr HG, et al. The prevalence and correlates of eating disorders in the National Comorbidity Survey Replication. Biological Psychiatry, 2007, 61(3): 348-358.
37. Spencer EA, Appleby PN, Davey GK, et al. Validity of self-reported height and weight in 4808 EPIC-Oxford participants. Public Health Nutrition, 2002, 5(4): 561-565.
38. Gorber SC, Tremblay M, Moher D, et al. A comparison of direct vs. self-report measures for assessing height, weight and body mass index: a systematic review. Obes Rev, 2007, 8(4): 307-326.
39. Meyer C, Arcelus J, Wright S. Accuracy of self-reported weight and height among women with eating disorders: a replication and extension study. Eur Eat Disord Rev, 2009, 17(5): 366-370.
40. White MA, Masheb RM, Grilo CM. Accuracy of Self-reported Weight and Height in Binge Eating Disorder: Misreport Is Not Related to Psychological Factors. Obesity, 2010, 18(6): 1266-1269.
41. OECD health data 2005. http://www.nationmaster.com/graph/hea_obe-health-obesity