Mental health consequences of overstretch in the UK Armed Forces, 2007–09: a population-based cohort study

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Summary

Background Concerns have been raised about the effect of tour length on the mental health of the UK armed forces. In 2007, we reported that cumulative length of deployment was associated with mental illness in military personnel. Our findings provided empirical evidence to support the UK advisory policy for tour length, known as the Harmony Guidelines. If fully implemented, these guidelines could aid prevention of mental illnesses. We aimed to reassess the association between cumulative length of deployment and number of deployments with mental illness in the UK forces.

Methods Our analysis was based on data from a representative study of the military for UK regular personnel who had completed a questionnaire between Nov 2, 2007, and Sept 24, 2009, and were deployed in the 3 years before questionnaire completion. Study outcomes were presence of possible post-traumatic stress disorder (PTSD), psychological distress, multiple physical symptoms, alcohol misuse, problems at home during and after deployment, and relationship or family problems. The key independent factors were deployment for 13 months or more, and months and number of deployments in the past 3 years.

Findings 8278 regulars responded to the questionnaire, of whom 3982 (48%) had been deployed in the 3 years before questionnaire completion. Deployment for 13 months or more decreased from 22% in March, 2005, (median March 8, 2005 [IQR Oct 10, 2004 to April 28, 2005]), to 12% in May, 2008, (May 17, 2008, [Feb 14, 2008, to Dec 5, 2008]). We noted an association between cumulative time deployed as a continuous variable and a score of 40 or more on the PTSD checklist (p=0·002), presence of psychological distress (p=0·018), and multiple physical symptoms (p=0·030; table 2). Furthermore, 13 months or more of deployment was associated with multiple physical symptoms (adjusted odds ratio [OR] 2·15, 95% CI 1·39–3·32), a PTSD checklist score of 40 or more (2·02, 1·31–3·12), and problems at home, but not a PTSD checklist score of 50 or more (1·50, 0·82–2·75), psychological distress 1·34, 0·98–1·85), or alcohol misuse (1·32, 0·97–1·80). Number of deployments was not associated with worse mental illness status or problems at home.

Interpretation The Harmony Guidelines can prevent mental illness in the UK Armed Forces and, since 2006, their introduction has prevented personnel from being deployed for a longer period than recommended in the guidelines. Monitoring of cumulative length of deployment might reduce mental illness in the UK military.

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Introduction

Concerns about tour length and frequency in the UK military led to development of the Harmony Guidelines, which specify maximum allowable periods of deployment for each service. The guidelines are intended to monitor the pace of military deployments of the UK Armed Forces. Findings from our 2007 study[1] showed that 22% of deployed personnel had tour lengths that were longer than the Harmony Guidelines' threshold of 13 months or more in the past 3 years. We noted that violation of this threshold was associated with several mental health outcomes.[1] Consistency of our findings for all the outcomes assessed was remarkable, providing empirical evidence of the damaging effect of overstretch—ie, the pace of military deployments.

By contrast, UK studies based on the Iraq and Afghanistan conflicts have consistently shown no association between military deployment and psychological distress and post-traumatic stress disorder (PTSD) in regular personnel (ie, those in full-time military employment), but the prevalence of both illnesses is higher in soldiers with a combat role.[2-4] Deployment is associated with various somatic symptoms[2] and alcohol misuse,[3] probably of short duration, after which people return to pre-deployment alcohol use, albeit still at a high level.[5]

In the present study we used new data to revisit the effect of the harmony guidelines on mental health problems at home. This issue remains topical because as the UK military strives to increase efficiency, amid a continuous decrease in the strength of regular forces, an increase in the length of a deployment to, for example, 9 months, or a shorter break between deployments from the present duration of 24 months to perhaps 18 months are obvious possible targets. Several other non-UK-based studies have been done, but the results have been inconsistent.[6-10] Our previous report was based on service personnel who were deployed between 2003 and the

beginning of 2006, and who completed a questionnaire in March, 2005, (median March 8, 2005 [IQR Oct 10, 2004 to April 28, 2005]; phase 1).[1] This period was characterised by intense activity, with roughly 100 000 UK military personnel deployed to Iraq.[2] We have replicated our analysis on the basis of a study undertaken in May, 2008, (median May 17, 2008, [IQR Feb 14, 2008, to Dec 5, 2008]; phase 2).[3] This period was characterised by a continuation of the hostilities in Iraq and intensification of the UK's involvement in the campaign in Afghanistan. Military personnel could have been deployed to both Iraq and Afghanistan. In the present study we aimed to assess the possible association of cumulative length of deployment and number of deployments with mental illnesses and problems at home in the 3 years before questionnaire completion.

Methods

Study design and participants

This analysis is based on data obtained during phase 2 of a cohort study of UK service personnel who completed a questionnaire between Nov 2, 2007, and Sept 24, 2009, and were deployed in the 3 years before questionnaire completion. The study consisted of four representative samples on the basis of separate sampling frames. The phase 1 samples, consisting of personnel deployed at the beginning of the Iraq war (codename Operation TELIC 1) and those who were in the military at the same time but not deployed to TELIC 1, were followed up at phase 2. Two new samples were added at phase 2: a random sample of personnel deployed to Afghanistan between April, 2006, and April, 2007 (codename Operation HERRICK), and those who joined the UK military between April, 2003, and April, 2007 (the replenishment sample) who might have been deployed to Iraq or Afghanistan. We added the two new samples to account for both the expansion of military activity in Afghanistan and the present demographic distribution of the UK armed forces.

As in our previous analysis,[1] we excluded reserves because the lengths of their deployments were noticeably shorter than those of regular personnel. We included only personnel deployed in the past 3 years because the main objective was to assess the length and frequency of deployment, not the association between deployment status and mental illness, which has been done previously.[4]

This study was approved by the Ministry of Defence Research Ethics Committee (MODREC) and the King's College Hospital local research ethics committee.

Outcomes

Study outcomes were presence of possible PTSD, psychological distress, multiple physical symptoms, alcohol misuse, problems at home during and after deployment, and relationship or family problems. The main independent variables were cumulative time of deployment, and number of times deployed, in the past 3 years.

Procedures

We assessed symptoms of PTSD with the PTSD checklist–civilian version, which unlike the military version is less restrictive in a population that might have suffered traumatic events unrelated to military activities; furthermore, the civilian version has been used in previous US and UK studies thus enabling comparison.[11] We defined possible PTSD as a score of 50 or more on the checklist, or of 40 or more (range 17–85) to account for borderline cases.[12] We measured symptoms of psychological distress with the General Health Questionnaire-12,[13] with cases defined as individuals with a score of 4 or more (range 0–12). We assessed multiple physical symptoms with a checklist of 53 symptoms, on the basis of the work of Derogatis and colleagues,[14] but with additional symptoms to represent new issues in the military.[2] We defined cases as individuals reporting 18 or more physical symptoms. We used a score of 16 or more (range 0–40) to define alcohol misuse with WHO's ten-item Alcohol Use Disorders Identification Test.[15] Problems during deployment included individuals not receiving enough support from the family, having serious financial problems, a partner or spouse leaving, problems with children, and other problems at home, and were defined as present or absent. We based problems at home after deployment on ten items including difficulty in adjustment to being back home, people not understanding what the person went through, individuals having difficulty resuming normal social activities, having financial problems, having been let down by others, and being physically violent towards a family member. These problems were divided into zero, one or two, and three or more problems. Relationship or family problems due to deployment were assessed via a yes or no question.

Deployments considered in this study were to Afghanistan, Iraq, and, for a small proportion of individuals, Pakistan, Bosnia, Kosovo, or the Persian Gulf. We categorised length of deployment as less than 5 months, 5–8 months, 9–12 months, and 13 months or more. According to the Harmony Guidelines, personnel should not be deployed for longer than 13 months during a period of 3 years to allow for a break of 24 months between deployments. We assessed number of combat-related events during last deployment on the basis of 16 statements modified from the Walter Reed Army Institute of Research Land Combat Study.[16]

Statistical analysis

We undertook several logistic or multinomial logistic regression analyses separately for the whole sample (all services); for the Royal Marines and Army combined, as the larger contributors to deployment; and for individuals with a combat role. We did multinomial logistic analysis for problems at home after deployment and logistic analyses for binary options for problems during deployment and relationship or family problems. We adjusted for age at questionnaire completion, sex, serving

status (still serving or left service), rank (commissioned officer, non-commissioned officers, or other ranks), service (Royal Navy, Royal Marines, Army, Royal Air Force), and marital status (married or living with partner, single, or separated, divorced, or widowed). Reference groups were the 5–8 months of cumulative deployment length and one deployment in the analysis of number of deployments. We also did analyses including length and frequency of deployment as continuous variables.

Weights were created to account for sampling fractions and for differences in response rate at phase 2. Weighted percentages and odds ratios (ORs) are presented in the tables with unweighted cell counts. For the purposes of these analyses we have combined all samples and sample weights have been generated to show the inverse probability of a participant from a specific subpopulation being sampled. Furthermore, response weights were generated to account for non-response. Response weights were defined as the inverse probability of an individual responding once sampled and were driven by factors shown empirically to predict response (sex, rank, age, and sample). The sample and response weights were multiplied together to generate one combined weight.[3] We did all analyses in STATA (version 11.2) with use of the survey commands.

Role of the funding source

The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. Defence Statistics identified the sample frames and selected a random sample on the basis of instructions from the study team. Defence Statistics supplied addresses and identifiers of those in the selected samples. NTF had full access to all the data in the study and the corresponding author had final responsibility for the decision to submit for publication.

Results

Altogether, 8278 (57%) of 14467 regulars responded: 746 regulars in the HERRICK sample and 2198 in the replenishment sample completed the questionnaire and 5334 regulars completed the questionnaire at follow-up. The analysis was based on the 3982 (48%) regulars who had deployment experience in the past 3 years before questionnaire completion. Table 1 presents the sociodemographic and service characteristics of the overall sample, the Royal Marines and Army, and those in a combat role in those two services. Most personnel were deployed from the Army; most deployed personnel were men, in a long-term relationship, and in active service; and 17% were commissioned officers. Individuals in a combat role had a lower mean age than those in the Royal Marines and the Army (table 1). The mean number of combat-related events during last deployment was almost four in the total sample and increased in personnel with a combat role (table 1). 12% of the total sample were deployed for 13 months or more in the 3 years before questionnaire completion (table 1). The Spearman correlation between cumulative length of deployment and number of deployments was 0·42 in the total sample, 0·50 in the Royal Marines and the Army, and 0·53 in those with a combat role.

We noted an association between cumulative time deployed and a score of 40 or more on the PTSD checklist, presence of psychological distress, and multiple physical

	Overall sample (N=3982)	Army and Royal Marines (n=2927)	Army and Royal Marines in combat roles (n=1230)
Deployment			
Iraq	1782 (50%)	1352 (50%)	563 (51%)
Afghanistan	905 (22%)	705 (23%)	291 (22%)
Both	1183 (25%)	812 (25%)	360 (25%)
Other*	112 (3%)	58 (3%)	16 (2%)
Service			
Royal Navy	267 (7%)	..	..
Royal Marines	188 (4%)	188 (5%)	129 (7%)
Army	2739 (71%)	2739 (95%)	1101 (93%)
Royal Air Force	788 (18%)	..	..
Sex			
Male	3649 (93%)	2729 (94·3%)	1220 (99·1%)
Female	333 (7%)	198 (5·7%)	10 (0·9)
Rank			
Officer	820 (17%)	534 (15·3%)	245 (17·1%)
Non-commissioned officer	2263 (64%)	1764 (66·8%)	606 (56·1%)
Other rank	899 (19%)	629 (17·9%)	379 (26·9%)
Mean months deployed	8·20 (4·83)	8·31 (4·55)	8·81 (4·56)
Mean age at questionnaire completion (years)	32·42 (8·37)	31·72 (8·00)	30·57 (7·60)
Marital status			
Married or living with partner	2979 (76%)	2180 (75·6%)	919 (5·5%)
Single	764 (17%)	584 (17·5%)	260 (19·1%)
Separated, divorced, or widowed	231 (7%)	159 (6·9%)	50 (5·4%)
Serving status			
Serving	3713 (93%)	2730 (92·7%)	1136 (91·9%)
Discharged	268 (7%)	197 (7·3%)	94 (8·1%)
Cumulative deployment length in the past 3 years (months)			
<5	679 (13%)	366 (12%)	116 (9%)
5–8	1822 (46%)	1480 (50%)	594 (48%)
9–12	1019 (26%)	789 (27%)	368 (30%)
>12	462 (12%)	292 (10%)	152 (13%)
Number of deployments in the past 3 years			
1	2484 (63%)	1945 (66%)	763 (62%)
2	1054 (27%)	793 (28%)	387 (32%)
≥3	444 (10%)	189 (7%)	80 (7%)
Mean number of combat-related events during last deployment	3·87 (4·35)	4·50 (4·28)	6·20 (4·65)

Data are n (%) or mean (SD). For mean (SD) values, distributions are skewed to the right. Weighted percentages are presented. Numbers might not add to totals because of missing data. Includes only regulars who have been deployed within the past 3 years and have health data obtained at phase 2 *Other deployments include Lebanon, Pakistan, Bosnia, Kosovo, and the Persian Gulf.

***Table 1*: Sociodemographic and military characteristics**

	PTSD (PTSD-checklist cutoff of ≥50; n=142)		PTSD (PTSD-checklist cutoff of ≥40; n=296)		Psychological distress (n=736)		Alcohol misuse (n=686)		Multiple physical symptoms (n=302)	
	n (%)	Adjusted OR* (95% CI)	n (%)	Adjusted OR* (95% CI)	n (%)	Adjusted OR* (95% CI)	n (%)	Adjusted OR* (95% CI)	n (%)	Adjusted OR* (95% CI)
Cumulative time deployed in the past 3 years (months)										
<5	23 (4%)	1·02 (0·56–1·88)	43 (6%)	0·78 (0·50–1·21)	122 (18%)	0·94 (0·71–1·25)	88 (13%)	0·88 (0·64–1·21)	54 (9%)	1·29 (0·86–1·94)
5–8	56 (4%)	1·0	121 (8%)	1·0	317 (18%)	1·0	314 (17%)	1·0	116 (7%)	1·0
9–12	42 (4%)	1·01 (0·62–1·63)	84 (8%)	1·02 (0·72–1·45)	208 (21%)	1·23 (0·97–1·56)	183 (17%)	1·03 (0·81–1·32)	86 (9%)	1·33 (0·94–1·89)
13+	21 (5%)	1·50 (0·82–2·75)	48 (12%)	2·02 (1·31–3·12)	89 (22%)	1·34 (0·98–1·85)	101 (21%)	1·32 (0·97–1·80)	46 (12%)	2·15 (1·39–3·32)
p value	..	0·394	..	0·002	..	0·018	..	0·052	..	0·030
Number of deployments in the past 3 years										
1	95 (4%)	1·0	189 (8%)	1·0	474 (20%)	1·0	445 (18%)	1·0	187 (9%)	1·0
2	40 (3%)	0·88 (0·57–1·38)	88 (8%)	1·06 (0·77–1·46)	191 (18%)	0·95 (0·76–1·19)	176 (16%)	0·89 (0·70–1·12)	83 (9%)	1·09 (0·79–1·50)
≥3	7 (2%)	0·43 (0·18–1·03)	19 (5%)	0·76 (0·42–1·37)	71 (18%)	0·93 (0·67–1·31)	65 (14%)	0·80 (0·56–1·13)	32 (9%)	1·23 (0·76–1·97)
p value	..	0·071	..	0·583	..	0·600	..	0·134	..	0·367

Weighted percentages are presented. Analyses are restricted to personnel with data for both months on deployment and number of deployments. Analyses are weighted for sample and response rates. PTSD=post-traumatic stress disorder. OR=odds ratio. *Adjusted for age (years), sex, serving status, rank, service, and marital status.

Table 2: **Association between cumulative deployment length and number of deployments in the last three years, and mental illnesses in the total sample (Royal Navy, Royal Marines, Army and RAF; N=3982)**

symptoms (table 2). Furthermore, we recorded a significant association between personnel who were deployed for 13 or more months in the past 3 years and a score of 40 or more on the PTSD checklist, and presence of multiple physical symptoms (table 2). The ORs for cumulative length of deployment and the other mental illness outcomes were between 1·3 and 1·5, but they were not statistically significant (table 2). No association between number of deployments and the mental illness outcomes was noted; however, the OR in the group who were deployed three or more times was lower than for the other groups (table 2).

Cumulative length of deployment was associated with problems at home during and after deployment, and with relationship or family problems, but there was no association with number of deployments (table 3). We noted a consistent effect of cumulative length of deployment on post-deployment problems at home; personnel with no problems tended to have a shorter cumulative length of deployment, and those with three or more problems tended to have a longer cumulative length, than those with one or two problems (table 3).

In the analyses restricted to Royal Marines and Army personnel, or to those with a combat role, there was no significant association between cumulative deployment length and mental illness outcomes, except for with multiple physical symptoms (adjusted OR 1·96, 95% CI 1·21–3·16 in Royal Marines and Army personnel in deployed for 13 months or more months; data available from authors on request). Likewise no association was shown between number of deployments and mental ill health (data available on request). As in the total sample, problems at home during and after deployment, and relationships and family problems, increased with increasing cumulative length of deployment in personnel in the Royal Marines or the Army (data not shown). We noted a significant association between problems at home after deployment in personnel with a combat role and cumulative length of deployment (p=0·04) and problems were more common in those deployed for 13 months or more than in those deployed for shorter durations (adjusted OR 1·59, 95% CI 0·99–2·55). Problems at home after deployment were negatively associated with number of times deployed in personnel with a combat role (data not shown).

We recorded a significant association between three or more deployments and no problems at home in personnel with a combat role (data available from the authors on request). Although not statistically significant, possible PTSD tended to be less frequent in personnel with more deployments (data not shown).

Months of deployment as a continuous variable was significantly associated with presence of mental illnesses, problems at home, and relationship or family problems due to deployment (tables 4, 5). The association was also significant for multiple physical symptoms, a PTSD checklist score of 40 or more, problems at home, and relationship and family problems in the Army and Marines analysis (table 4). The only exception was length of deployment and

	Problems at home during deployment (n=1134)		No problems at home after deployment (n=1075)		One or two problems after deployment (n=1565)		Three of more problems after deployment (n=1212)		Relationship or family problems related to deployment (n=534)	
	n (%)	Adjusted OR* (95% CI)	n (%)	Adjusted multinomial OR* (95% CI)	n (%)	Adjusted multinomial OR* (95% CI)	n (%)	Adjusted multinomial OR* (95% CI)	n (%)	Adjusted multinomial OR* (95% CI)
Cumulative time deployed in the past 3 years (months)										
<5	175 (29%)	0·91 (0·71–1·16)	252 (41%)	1·51 (1·17–1·94)	254 (39%)	1·0	139 (20%)	0·65 (0·49–0·86)	69 (10%)	0·73 (0·52–1·03)
5–8	516 (31%)	1·0	474 (27%)	1·0	738 (40%)	1·0	573 (33%)	1·0	228 (13%)	1·0
9–12	290 (33%)	1·06 (0·87–1·31)	247 (25%)	0·89 (0·70–1·13)	411 (42%)	1·0	331 (34%)	0·97 (0·78–1·21)	166 (19%)	1·48 (1·14–1·93)
≥13	153 (38%)	1·52 (1·16–2·00)	102 (23%)	0·91 (0·65–1·27)	162 (37%)	1·0	169 (41%)	1·51 (1·13–2·04)	71 (18%)	1·70 (1·19–2·43)
p value	..	0·003	..	0·001	..	..	..	<0·0001	..	<0·0001
Number of deployments										
1	694 (32%)	1·0	657 (28·2%)	1·0	956 (39·5%)	1·0	764 (32%)	1·0	133 (15%)	1·0
2	304 (31%)	0·94 (0·77–1·14)	288 (27·5%)	0·96 (0·77–1·19)	425 (41·1%)	1·0	330 (31%)	0·94 (0·77–1·16)	159 (16%)	1·13 (0·88–1·46)
≥3	136 (33%)	1·10 (0·84–1·45)	130 (29·1%)	1·00 (0·74–1·36)	184 (40·2%)	1·0	118 (31%)	1·04 (0·77–1·42)	42 (14%)	1·03 (0·69–1·52)
p value	..	0·832	..	0·850	..	..	..	0·947	..	0·557

Weighted percentages are presented. Analyses are restricted to personnel with data for both months on deployment and number of deployments. Analyses are weighted for sample and response rates. OR=odds ratio. *Adjusted for age (years), sex, serving status, rank, service, and marital status.

***Table 3*: Association between cumulative deployment length and number of deployments in the past 3 years, and problems at home during deployment and post deployment in the total sample (Royal Navy, Royal Marines, Army, and Royal Air Force; N=3982)**

possible PTSD when a score of 50 or more was used (table 4). Only post-deployment problems at home and relationship and family problems were associated with cumulative length of deployment in personnel with a combat role (table 5).

Discussion

Our findings show an association between cumulative length of deployment of longer than 3 years and mental illnesses, problems at home, and relationship and family problems related to deployment. Deployment for 13 months or more in the past 3 years was associated with multiple physical symptoms, a PTSD-checklist score of 40 or more, problems at home, and relationships and family problems, but the effect sizes were small. Although the OR estimates were similar to those previously reported,[1] deployment for 13 months or more was not significantly associated with a PTSD-checklist score of 50 or more, psychological distress, or alcohol misuse. Number of deployments in the past 3 years was not associated with mental illnesses or problems at home. Furthermore, there was no evidence that personnel in a combat role who were deployed for 13 months or more were more likely to have mental illnesses than those deployed for shorter durations.

The effect of deployment was difficult to distinguish as distinct from the effects of service in a combat role or combat exposure, not least because evidence shows that

	Possible PTSD (PTSD cutoff of ≥50)	Possible PTSD (PTSD cutoff of ≥40)	Psychological distress	Alcohol misuse	Multiple physical symptoms	Problems at home during deployment
Overall sample	1·03 (0·98–1·08)	1·06 (1·03–1·10)	1·03 (1·00–1·05)	1·02 (1·00–1·05)	1·04 (1·01–1·08)	1·04 (1·02–1·06)
Army and Marines	0·99 (0·93–1·06)	1·06 (1·02–1·11)	1·02 (0·99–1·05)	1·01 (0·98–1·04)	1·04 (1·00–1·08)	1·04 (1·01–1·06)
Army and Marines in combat roles	1·02 (0·94–1·11)	1·07 (1·01–1·13)	1·03 (0·98–1·07)	0·99 (0·95–1·04)	1·05 (0·99–1·11)	1·00 (0·96–1·04)

Data are adjusted OR (95% CI). Adjusted for age (years), sex, serving status, rank, service, and marital status. PTSD=post-traumatic stress disorder.

***Table 4*: Adjusted analyses with months on deployment as a continuous variable**

	Problems at home after deployment			Relationship or family problems related to deployment
	None	1–2	≥3	
Overall sample	0·96 (0·93–0·99)	1·0	1·04 (1·02–1·07)	1·07 (1·04–1·09)
Army and Marines	0·96 (0·92–0·99)	1·0	1·03 (1·00–1·06)	1·09 (1·05–1·13)
Army and Marines in combat roles	1·00 (0·95–1·05)	1·0	1·04 (1·00–1·09)	1·08 (1·03–1·13)

Data are adjusted OR (95% CI). Adjusted for age (years), sex, serving status, rank, service, and marital status.

***Table 5*: Adjusted analyses of problems at home and relationship or family problems, with months on deployment as a continuous variable**

service in combat roles or increasing combat exposure during deployment are associated with PTSD and other mental health problems.[2,3,16-18] We noted that the ORs were similar in the total sample and in those with a combat role, suggesting that our results were not due to combat exposure. The estimates of cumulative length of deployment during a 3 year period, and each of the mental health outcomes in this study, were similar to those reported previously,[1] but the association was significant only for multiple physical symptoms and a PTSD-checklist score of 40 or more, an outcome not included in our previous study.

***Panel*: Research in context**

Systematic review

We searched Web of Science on June 17, 2014, with an additional search of PsychInfo to check for any references that might have been missed in the initial search. The search included references of papers published between 2003, and 2014, with search terms "Duration of deployment" OR "length of deployment" OR "deployment length" OR "deployment duration" OR "number of deployments" OR "repeated deployments" provided 131 references. We did a second, more restrictive, search by adding AND {PTSD OR Posttraumatic* ORCMD OR "common mental disorders" OR "psychological distress" OR Alcohol OR "unexplained symptoms"}, which provided 39 references. We excluded references that did not refer to Iraq or Afghanistan, that compared deployment and control groups (not deployed), that included length of only one deployment, or that provided only abstracts from conferences.

Only one study of cumulative length of deployment[1] was available in a previous systematic review[25] and no systematic review has been done for number of deployments. In a Web of Science search, we obtained 131 reports about the effect of number and cumulative length of deployments on mental health in Iraq and Afghanistan between 2002 and 2014. Altogether ten reports were deemed relevant in relation to number of deployments: eight from our search and two from other sources. Five reports showed a positive association between number of deployments and post-traumatic stress disorder (PTSD),[8,10,22,23,26] but two reports showed no association.[1-9] There were as many positive associations as no associations or an association in the opposite direction for mood disorders, alcohol misuse, anxiety, and somatic symptoms.[1,8,22-24,26] The six reports assessing cumulative length of deployment usually over a set time period, generally 3 years,[1,6-10] show absence of consistency in the findings for PTSD and somatic symptoms, two papers reported an association in relation to alcohol misuse[1,6] and one an association with anxiety.[7] The effect of the length of a single deployment was excluded in this review. Differences in the definition of outcomes, adjustment for confounders, combat exposure, or combat role between studies might have contributed to the low consistency of findings between reports.

Interpretation

Deployment is an essential component of military life, but its characteristics might affect levels of satisfaction, stress at home, and mental illness of service personnel and their family. The long duration of the Iraq and Afghanistan conflicts tested the effects of deployment on mental illness. Our findings show that cumulative length of deployment for longer than recommended by the Army Harmony Guidelines has an effect on mental illness and that this effect could be decreased if the chain of command adheres to the Harmony Guidelines. However, the reasons why the results in the UK studies are only partly replicated in other armed forces and why, in our studies, number of deployments is not associated with mental illness are unclear. The dilemma is whether one should act on the basis of divergent results. Our results support use of the Harmony Guidelines in the UK military, which is a policy that can be monitored and its effect on mental illness measured.

The most probable explanation for the difference between our previous results and the present findings is that the statistical power to make inferences decreased because only 12% of personnel were deployed for longer than recommended in the Army Harmony Guidelines in phase 2 compared with 22% in phase 1.[1] This explanation is further supported by the association between cumulative length of deployment as a continuous variable and all our outcomes in the total sample, and that a PTSD-checklist score of 40 or more, but not 50 or more, showed a statistically significant association. Three other studies have likewise shown an association;[1,6,7] however, a similar number of reports have not reported an association.[8-10] Possible explanations could be differences in the way armed forces operate in different countries or methodological issues related to statistical power.

The consistent association between deployment length and problems at home could be a mediating factor in the association between cumulative deployment length and mental illness. The cross-sectional design of the study does not allow us to establish the temporal association between these factors. In support of our results, length of deployment was negatively related to rates of re-enlistment over time in the US military.[19] Failure to re-enlist was more common in personnel who were deployed for more than 12 months than in those deployed for shorter durations. Another study reported that a longer dwell time (ie, the interval period at home between two successive deployments relative to the first deployment length) was associated with decreased risk of PTSD,[20] but this finding was not supported by another study.[21]

An unexpected, albeit non-significant, finding in our study was that number of deployments tended to be negatively associated with possible PTSD and not associated with other health outcomes or problems at home. Several studies have reported a positive association between number of deployments and mental illnesses,[8,20-24] but others have reported a negative association[3,9,21] or an association for PTSD but not for other mental illness outcomes (panel).[23] Similar absence of consistency has been reported for the possible effects of length of one deployment.[27]

Although the cumulative length of deployment and number of deployments in 3 years were associated with mental illness outcomes in our study, the two variables are not equivalent. The absence of a high correlation is due to the differences in deployment policy between the service branches of the UK military, but the association might also be affected by a chain-of-command decision that an individual is not deployable, or a request from an individual to not deploy for personal reasons. Possibly, most of these individuals could have a mental health problem or a serious problem at home. Furthermore, in special cases, service personnel might be deployed for a reduced period of time because of health and family problems. These explanations could all attenuate the association between cumulative length of deployments

or number of deployments and mental illness, but the net effect might not be the same for these two variables.

The role of the family can likewise influence the effect of deployment on service personnel. Deployment extensions have an effect on spouses of army personnel in terms of relationships, child care and problems at home,[28] and use of mental health services.[29]

This is a large cohort study with a satisfactory response rate considering that the population is highly mobile, young, and mainly male. Although a 57% response rate might not be regarded as high, it is rarely achieved in representative samples in other military studies. Both our outcomes and our independent variables are self-reported and random misclassification could have taken place. Additionally, the absence of anonymity could have prevented participants from admitting symptoms of mental illnesses.[30] This effect was noted in relation to PTSD, but not psychological distress, in one of our studies.[31] However, we are not aware of any empirical data showing a systematic bias in non-report of PTSD symptoms according to length of deployment. These sources of inaccuracy might cause attenuation of effects. The length of deployment for an individual can be altered by the chain of command on the basis of considerations related to the individuals and to operational concerns. The net effect of these decisions is difficult to model. We adjusted for possible confounders, but an unknown factor might have affected our results.

104 342 episodes of deployment took place between Nov 15, 2004, and Sept 14, 2009, and we estimated, on the basis of our data for number of deployments during 3 years, that 79 176 service personnel would have been deployed. Extrapolating from our results, a decrease from 22% to 12% in personnel deployed for longer than recommended by the Harmony Guidelines might have prevented 138 cases of PTSD, 453 cases of psychological distress, 309 cases of multiple physical symptoms, and 490 cases of alcohol misuse, a total of 1389 cases. This number would be reduced by 10% if reserves are excluded from the calculation. Some individuals might have more than one mental illness outcome.

The Harmony Guidelines fulfil an important policy role to limit maximum periods of deployment during a defined period of time. Cumulative length of deployment should be monitored because it might prevent an increase in levels of stress and mental illness in the UK military.

Contributors

RJR is a principal investigator of the study, planned and sought funding for the study, designed analysis, and was the lead author. NTF is a principal investigator, was involved in data collection, was responsible for data processing, discussed and undertook analysis, and provided comments on all drafts of the manuscript. MJ was involved in data collection, data processing, planning and design of study, and provided comments on all drafts. MK contributed to analysis of long-term relationship in deployed personnel and provided comments on all drafts. LH was responsible for study coordination, was involved in the design and planning of the study, and provided comments on the report. SW is a principal investigator; planned, designed, and sought funding for the study; and provided comments on all drafts.

Declaration of interests

SW is paid by King's College London, is an honorary civilian consultant adviser in psychiatry to the British Army, and a trustee of Combat Stress—a UK charity that provides service and support for veterans with mental health problems. RJR is paid by a Department of Defense award grant (number W81XWH-10-1-0881) of the US Congressionally Directed Medical Research Programs. MK is paid by the Support to the Families Wounded Injured and Sick study and the Stigma study (Ministry of Defence grant; BAE reference numbers 4500079324 and TIN 2.025). MJ and LH are paid by the King's Centre for Military Health Research grant. NTF is paid by Academic Centre for Defence Mental Health grant (number CTLBC/991).

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References

1 Rona RJ, Fear NT, Hull L, et al. Mental health consequences of overstretch in the UK armed forces: first phase of a cohort study. *BMJ* 2007; **335:** 603.

2 Hotopf M, Hull L, Fear NT, et al. The health of UK military personnel who deployed to the 2003 Iraq war: a cohort study. *Lancet* 2006; **367:** 1731–41.

3 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. *Lancet* 2010; **375:** 1783–97.

4 Jones M, Sundin J, Goodwin L, et al. What explains post-traumatic stress disorder (PTSD) in UK service personnel: deployment or something else? *Psychol Med* 2013: **43:** 1703–12.

5 Hooper R, Rona RJ, Jones M, Fear NT, Hull L, Wessely S. Cigarette and alcohol use in the UK Armed Forces, and their association with combat exposures: a prospective study. *Addict Behav* 2008; **33:** 1067–71.

6 Spera C, Thomas RK, Barlas F, Szoc R, Cambridge MH. Relationship of military deployment recency, frequency, duration, and combat exposure to alcohol use in the Air Force. *J Stud Alcohol Drugs* 2011; **72:** 5–14.

7 Armed Forces Health Surveillance Center. Health of women after wartime deployments: correlates of risk of selected medical conditions among females after initial and repeat deployments Afghanistan and Iraq, active component, US Armed Forces. *MSMR* 2012; **19:** 2–10.

8 Bleier J, McFarlane A, McGuire A, Treloar S, Waller M, Dobson A. Risk of adverse health outcomes associated with frequency and duration of deployment with the Australian Defence Force. *Mil Med* 2011; **176:** 139–46.

9 Boulos D, Zamorski MA. Deployment-related mental disorders among Canadian Forces personnel deployed in support of the mission in Afghanistan, 2001–2008. *CMAJ* 2013; **185:** E545–52.

10 Phillips CJ, Leardmann CA, Gumbs GR, Smith B. Risk factors for posttraumatic stress disorder among deployed US male marines. *BMC Psychiatry* 2010; **10:** 52.

11 Sundin J, Herrell RK, Hoge CW, et al. Mental health outcomes in US and UK military personnel returning from Iraq. *Br J Psychiatry* 2014; **204:** 200–07.

12 Blanchard EB, Jones-Alexander J, Buckley TC, Forneris CA. Psychometric properties of the PTSD Checklist (PCL). *Behav Res Ther* 1996; **34:** 669–73.

13 Goldberg DP, Gater R, Sartorius N, et al. The validity of two versions of the GHQ in the WHO study of mental illness in general health care. *Psychol Med* 1997; **27:** 191–97.

14 Derogatis LR, Lipman RS, Rickels K, Uhlenhuth EH, Covi L. The Hopkins Symptom Checklist (HSCL): a self-report symptom inventory. *Behav Sci* 1974; **19:** 1–15.

15 Babor TF, Higgins-Biddle JC, Saunders JB, Monteiro MG. AUDIT: the Alcohol Use Disorders Identification Test. Guidelines for use in primary care, 2nd edn. Geneva: WHO Department of Mental Health and Substance Dependence, 2001.

16 Hoge CW, Castro CA, Messer SC, McGurk D, Cotting DI, Koffman RL. Combat duty in Iraq and Afghanistan, mental health problems, and barriers to care. *N Engl J Med* 2004; **351:** 13–22.

17 Smith B, Wingard DL, Ryan MA, Macera CA, Patterson TL, Slymen DJ. US military deployment during 2001–2006: comparison of subjective and objective data sources in a large prospective health study. *Ann Epidemiol* 2007; **17:** 976–82.

18 Rona RJ, Hooper R, Jones M, et al. The contribution of prior psychological symptoms and combat exposure to post Iraq deployment mental health in the UK military. *J Trauma Stress* 2009; **22:** 11–19.

19 Hosek J. How is deployment to Iraq and Afghanistan affecting US service members and their families? Santa Monica, CA: RAND, 2011.

20 MacGregor AJ, Han PP, Dougherty AL, Galarneau MR. Effect of dwell time on the mental health of US military personnel with multiple combat tours. *Am J Public Health* 2012; **102** (suppl 1): S55–59.

21 Armed Forces Health Surveillance Center. Associations between repeated deployments to Iraq (OIF/OND) and Afghanistan (OEF) and post-deployment illnesses and injuries, active component, US Armed Forces, 2003–2010. Part II. Mental disorders, by gender, age group, military occupation, and "dwell times" prior to repeat (second through fifth) deployments. *MSMR* 2011; **18:** 2–11.

22 Allison-Aipa TS, Ritter C, Sikes P, Ball S. The impact of deployment on the psychological health status, level of alcohol consumption, and use of psychological health resources of postdeployed US Army Reserve soldiers. *Mil Med* 2010; **175:** 630–37.

23 Reger MA, Gahm GA, Swanson RD, Duma SJ. Association between number of deployments to Iraq and mental health screening outcomes in US Army soldiers. *J Clin Psychiatry* 2009; **70:** 1266–72.

24 Armed Forces Health Surveillance Center. Associations between repeated deployments to OEF/OIF/OND, October–December 2010, and post-deployment illnesses and injury, active component, US Armed Forces. *Medical Surveillance Monthly Report* 2011; **18:** 2–11.

25 Buckman JEJ, Sundin J, Greene T, et al. The impact of deployment length on the health and well-being of military personnel: a systematic review of the literature. *Occup Environ Med* 2011; **68:** 69–76.

26 Escolas SM PB, Safer MA, Bartone PT. The protective value of hardiness on military posttraumatic stress symptoms. *Military Psychology* 2013; **25:** 116–23.

27 Sareen J, Belik SL, Stein MB, Asmundson GJ. Correlates of perceived need for mental health care among active military personnel. *Psychiatr Serv* 2010; **61:** 50–57.

28 SteelFisher GK, Zaslavsky AM, Blendon RJ. Health-related impact of deployment extensions on spouses of active duty army personnel. *Mil Med* 2008; **173:** 221–29.

29 Mansfield AJ, Kaufman JS, Marshall SW, Gaynes BN, Morrissey JP, Engel CC. Deployment and the use of mental health services among US Army wives. *N Engl J Med* 2010; **362:** 101–09.

30 Warner CH, Appenzeller GN, Grieger T, et al. Importance of anonymity to encourage honest reporting in mental health screening after combat deployment. *Arch Gen Psychiatry* 2011; **68:** 1065–71.

31 Fear NT, Seddon R, Jones N, Greenberg N, Wessely S. Does anonymity increase the reporting of mental health symptoms? *BMC Public Health* 2012; **12:** 797.