The health of UK military personnel who deployed to the 2003 Iraq war: a cohort study

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Summary

Background **Concerns have been raised about the mental and physical health of UK military personnel who deployed to the 2003 war in Iraq and subsequent tours of duty in the country.**

Methods **We compared health outcomes in a random sample of UK armed forces personnel who were deployed to the 2003 Iraq war with those in personnel who were not deployed. Participants completed a questionnaire covering the nature of the deployment and health outcomes, which included symptoms of post-traumatic stress disorder, common mental disorders, general wellbeing, alcohol consumption, physical symptoms, and fatigue.**

Findings **The participation rate was 62·3% (n=4722) in the deployed sample, and 56·3% (n=5550) in the non-deployed sample. Differences in health outcomes between groups were slight. There was a modest increase in the number of individuals with multiple physical symptoms (odds ratio 1·33; 95% CI 1·15–1·54). No other differences between groups were noted. The effect of deployment was different for reservists compared with regulars. In regulars, only presence of multiple physical symptoms was weakly associated with deployment (1·32; 1·14–1·53), whereas for reservists deployment was associated with common mental disorders (2·47, 1·35–4·52) and fatigue (1·78; 1·09–2·91). There was no evidence that later deployments, which were associated with escalating insurgency and UK casualties, were associated with poorer mental health outcomes.**

Interpretation **For regular personnel in the UK armed forces, deployment to the Iraq war has not, so far, been associated with significantly worse health outcomes, apart from a modest effect on multiple physical symptoms. There is evidence of a clinically and statistically significant effect on health in reservists.**

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Introduction

There is no doubt that service personnel returning from military deployments are at risk of both mental and physical illness. Increased rates of several physical symptoms, and psychiatric disorders such as depression, anxiety, and post-traumatic stress disorder (PTSD), have been reported in many controlled epidemiological studies after deployments dating back as far as the American Civil War, and have been prominent in recent conflicts.[1–6] Despite these recognised associations, systematic epidemiological research has not been done until many years after deployments have ended. This delay has led to a range of methodological difficulties, including selection biases (due to low participation rates and exclusion of participants who have left the military), recall biases,[7] and difficulties in determining causal pathways between deployment-related hazards and later health outcomes.[8] Although some broad similarities might exist in the stresses experienced during different deployments, each has its own particular range of hazards. High-quality information on health outcomes after deployment is necessary to plan health services for serving and ex-serving personnel.

In the present study, we assessed the mental and physical health of UK veterans of the 2003 Iraq war. Our immediate focus was on Operation TELIC 1, which represented the build up and completion of major combat operations from Jan 18 to June 28, 2003. During this time about 46 000 UK service personnel were deployed. Since June, 2003, UK forces have continued to be deployed in southeastern Iraq and neighbouring areas, and by the end of 2005, 100 000 UK military personnel had served in the Joint Operational consecutive roulements of Operation TELIC. By February, 2006, 103 UK service personnel had died. There has been great concern in the UK media about the psychological effects of this deployment for UK service personnel.[9,10] Evidence from a large epidemiological study showed that US service personnel who deployed to Iraq in combat units had substantially higher rates of anxiety, depression, and PTSD symptoms than similar samples who were surveyed before deployment.[11] Routine screening for PTSD and depression has also indicated higher than expected rates in US service personnel.[12]

We aimed to compare the mental and physical health of UK armed forces personnel who had served in Operation TELIC 1 with that of a military group who had not, with two primary outcomes: common mental disorders and symptoms of PTSD.

Methods

Study design and participants

This was the first stage of data collection of a planned cohort study in which we compared mental and physical health outcomes in two groups: individuals who had deployed on Operation TELIC 1, and individuals who

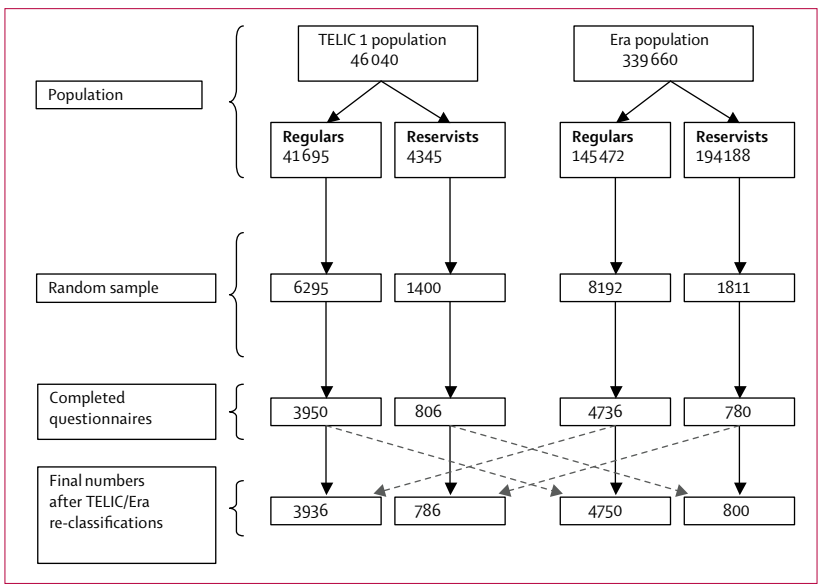

Figure 1: **Summary of sampling and response**
*Stratified by service and enlistment type. Numbers include a few participants who were subsequently excluded from the study. See text for more information.

were in the military at that time, but who were not deployed on Operation TELIC 1.

The first phase of deployment where major combat duties took place was designated TELIC 1 and took place from Jan 18, 2003, to June 28, 2003. Subsequent deployments, each lasting about 6 months, have been designated TELIC 2, 3, and so on. The study was initially designed to compare the health of those deployed on Operation TELIC 1 with non-deployed service personnel. When we make this comparison we refer to the deployed sample as Operation TELIC 1. However, we make comparisons where personnel from the comparison group who had served in later Operation TELICs were reassigned to the deployed group, which we then refer to as the Iraq war group.

Participants were identified by the UK Ministry of Defence's Defence Analytical Services Agency (DASA). A list of all personnel, excluding special forces and high-security personnel, who had deployed on Operation TELIC 1 between Jan 18 and April 28, 2003, was generated. At the time when the study was designed, the end date for Operation TELIC 1 was April 28, 2003. Subsequently, Permanent Joint Headquarters redefined the end date to June 28, 2003, and we used their definition when describing the effect of individual TELIC deployments. A similar list of all UK service personnel serving in the armed forces on March 31, 2003, but not in the TELIC 1 group was generated as the comparison group, which we refer to as Era. A random stratified sample was selected from the TELIC and Era populations. Sampling was done by assigning each individual to a stratum with a random number, sorting them into ascending order, and selecting the first x individuals where x was the sample size for the stratum. The stratification variables were service (Royal Navy including Royal Marines, Army, Royal Air Force [RAF]) and enlistment type (regular or reserve). The number of Era personnel sampled in each stratum was calculated from the proportions of personnel in each TELIC stratum. More individuals were sampled into the Era cohort, to take into account the 10% of regular military personnel who are medically downgraded (which indicates that an individual may not be fit to deploy) at any one time. The extra individuals were also sampled to allow for the likelihood that some of the personnel in the Era cohort would have been deployed to subsequent TELIC operations. Because particular concerns had been raised about the effect of deployment on reservists, who constituted a numerically small proportion of those deployed, we oversampled this group by a ratio of 2:1. The details of sampling and recruitment are shown in figure 1. 7695 TELIC 1 personnel and 10 003 Era personnel were sampled. We were regularly updated on deaths among potential participants by DASA, in order to avoid sending questionnaires and causing distress to families. 23 participants died before they could be sent questionnaires. We subsequently found that 176 individuals were ineligible for other reasons; 135 reservists were non-deployable, and address data were not supplied for 41 other people. The final number of individuals we actively followed up was 17 499.

The study received approval from the Ministry of Defence (Navy) personnel research ethics committee and the King's College Hospital local research ethics committee.

Procedures

We devised and piloted a 28-page questionnaire booklet, which included the information that participation in the survey was entirely voluntary, and that the researchers were independent of the Ministry Of Defence. The questionnaire consisted of seven sections: (1) demographics; (2) service information (including information on those no longer serving, current or last rank, and details of previous deployments); (3) experiences before deployment (including expectations and receipt of vaccinations); (4) experiences on deployment (including duty, potentially traumatic experiences, and morale); (5) experiences after deployment; (6) information on current health; and (7) background information, including past medical history and adversity in early life. For the Era sample, participants were only asked to complete sections 3–5 if they had served on one of the following major deployments since 2000: Afghanistan, Bosnia, Kosovo, Macedonia, Sierra Leone, Southern Turkey, Kuwait, Saif Sareea (a military exercise in Oman, 2002) and Iraq (Operation TELIC 2 and beyond). These deployments represented the main overseas operational activities of the UK armed forces since 2000. If Era participants had served on more than one of these deployments, they were asked to complete sections 3–5 for the most recent.

Section 6 (current health) consisted of the following measures. Symptoms of common mental disorder were measured with the General Health Questionnaire 12 (GHQ-12), a 12-item screening tool[13] with established validity.[14] Cases were defined as individuals with a score of 4 or more on this measure. Symptoms of PTSD were measured with the 17-item National Center for PTSD Checklist (PCL-C).[15] We defined cases as individuals with a total score of 50 or greater. A slightly different definition was used in the main previous US study of Iraq veterans,[11] which required a score of greater than 50, and that the participant scored moderate or above on one of the re-experiencing symptoms, three avoidance symptoms, and two hyperarousal symptoms; therefore we also did analyses using this outcome to define cases. We assessed fatigue with a 13-item fatigue scale,[16] with cases defined as individuals scoring 4 or more. Alcohol consumption and harmful use was measured with the WHO Alcohol Use Disorders Identification Test (AUDIT).[17] Cases were defined as individuals with a total score of greater than 13 for men and greater than 10 for women. These scores represent the top 25% highest scorers for each sex. Physical symptoms were ascertained with a checklist of 53 symptoms similar to those used in our previous cohort study in Gulf War veterans,[3] and we assigned a case definition of having multiple physical symptoms if 18 or more symptoms were endorsed, representing the top decile in the present sample.

We used several strategies to contact potential participants (figure 2). In the first instance, study participants were allocated either to receive a questionnaire by post, or, for selected serving personnel, were assigned a visit from the research team. Visits and mail-outs were done simultaneously. Visits were assigned on the basis of the distribution of the sample across military units by postcode. Military postcodes containing numbers of personnel above a certain threshold were assigned a visit. All remaining participants, including reservists and those who had already left the services, were sent questionnaires by post. A letter providing information about the study was sent to all participants assigned to the postal survey before the questionnaire was mailed. A number of approaches were used to raise the profile of the study, including a set of instructions sent from a central source to Commanding Officers and other relevant personnel issued in February, 2004, and updated in January, 2005; a series of articles in service publications; and information posted on services websites.

Data collection began in June, 2004, and ended on March 2, 2006, during which time the research team made more than 50 visits to military units across the UK and Germany. At each location, eligible personnel were assembled and asked to complete the questionnaire. Those who did not wish to participate could leave at any time. Non-attendance was usually because of work commitments, training, or courses, or because individuals had moved location, which included being deployed. Questionnaires were left behind for forwarding or completion at a later date. Those who had been assigned a visit, but had not been visited by March, 2005, or who had not responded after a visit, were subsequently sent a questionnaire by mail. Consequently, the data collection was staggered, with overlapping stages of mailing.

During data collection, alternative strategies for tracing participants were used. Military tracing consisted of several approaches: for reservists, permanent staff administrative officers were contacted by telephone and asked for their assistance in tracking personnel. To maximise response rates for regular service personnel, senior personnel at the units were directly emailed by the Ministry Of Defence requesting their assistance with the distribution of questionnaires and in locating highly mobile personnel. Immediately after the email, the research team dispatched batches of questionnaires for distribution and made telephone contact with the units. Between September and December, 2005, personnel from about 400 units across the three services were traced in this way.

In the case of ex-serving participants, addresses were checked against the electoral register, and telephone numbers were sought from directory enquiries (civilian tracing). 2493 addresses of ex-serving personnel were processed in this way. However, for 1842 (74%) of these addresses, no telephone number was available because either the individual was not listed, or they were ex-directory. To trace individuals for whom the address details were out of date, we sought permission to access contact information held on the National Strategic Tracing Service. A non-responder mailing to these addresses was done in January, 2006.

To assess potential response bias, we randomly selected 150 individuals who had not responded to three contacts, for intensive follow-up. This sample was equally divided

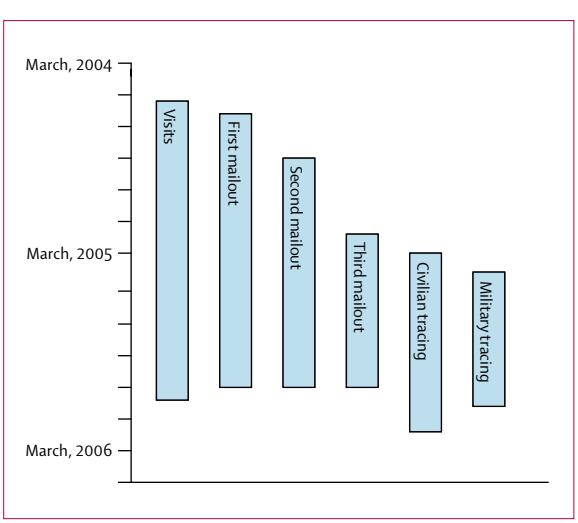

Figure 2: **Summary of follow-up**

	Number of contacts attempted	Number of completed questionnaires	Number of uncompleted questionnaires returned to sender
First mail-out	14316	5037 (35%)	713 (5%)
Second mail-out	7583	957 (13%)	372 (5%)
Third mail-out	3205	265 (8%)	214 (7%)
Fourth mail-out	104	6 (6%)	2 (2%)
NSTS mail-out	2420	133 (6%)	206 (9%)
Base visits	5726	2805 (49%)	470 (8%)
Civilian tracing	711	82 (12%)	24 (3%)
Military tracing	4352	987 (23%)	294 (7%)
Total	17499*	10272 (59%)	657* (4%)

NSTS=National Strategic Tracing Service. *More than one contact or return-to-sender could occur for each participant, so these are not column totals.

Table 1: **Response rate by method of contact attempted**

	Number (%) responded	Adjusted relative response rate (95% CI)
Age at Jan 1, 2005 (years)		
<25	1725 (49%)	1·0
25–29	1909 (56%)	1·1 (1·1–1·2)
30–34	2154 (62%)	1·3 (1·2–1·3)
35–39	2064 (64%)	1·3 (1·3–1·4)
40–49	1986 (62%)	1·3 (1·3–1·4)
≥50	434 (66%)	1·5 (1·4–1·6)
Sex		
Male	9239 (58%)	1·0
Female	1033 (64%)	1·2 (1·1–1·2)
Service		
Army	6603 (59%)	1·0
Royal Navy/Marines	1675 (56%)	0·9 (0·9–0·9)
Royal Air Force	1994 (59%)	0·9 (0·9–1·0)
Rank		
Officer	1900 (68%)	1·1 (1·1–1·2)
Other rank	8372 (57%)	1·0
Status		
Regular	8687 (60%)	1·0
Reservist	1585 (52%)	0·8 (0·7–0·8)
Deployment		
Era	5517 (56%)	1·0
TELIC	4755 (62%)	1·1 (1·1–1·2)
Ethnic group		
White	8670 (60%)	
Non-white	463 (51%)	
Address type		
Military	8003 (64%)	
Civilian UK	2005 (46%)	
Civilian overseas	56 (35%)	
Not known	208 (41%)	
Total responders	10272 (59%)	

Missing data: ethnic group 2204. *Relative response rates, adjusted for all variables in table except ethnic group and address type. Ethnic group is not included in the Poisson model because of large number of missing values.

Table 2: **Response rates for individuals who were sent questionnaires**

between the TELIC and Era cohorts, and included regulars, reservists, and ex-serving personnel. A short version of the questionnaire was initially mailed to these individuals, offering a small financial incentive. Researchers attempted to make telephone contact with those who did not reply, and did interviews by telephone where possible. Individuals for whom contact details were found to be incorrect were traced via the electoral register, directory enquiries, and the National Strategic Tracing Service.

Statistical analysis

Analyses were done in STATA 9 (Stata Corporation, College Station, TX, USA). Relative response rates were calculated with Poisson regression analysis using robust SEs. Where unstratified analyses for the entire sample are presented, we used appropriate survey commands (svy) to account for sampling fractions. Any significant differences between the proportions were identified using Pearson's χ^2 square statistic with the Rao and Scott second order correction, which generates an F value. The sociodemographic characteristics of the TELIC 1 sample were compared with those of the Era sample. We then described the prevalence of categorical outcomes (having a case of common mental disorder on the GHQ-12, the PCL-C, the fatigue scale, rating oneself's general health as fair or poor, and falling in the most symptomatic decile on physical symptoms). Odds ratios (OR) with 95% CI were calculated to express associations between cohorts on outcomes, and we controlled for potential confounders by logistic regression analysis. Model adequacy was tested with a specification test (linktest command in Stata) and a goodness of fit with the Hosmer-Lemeshow test.[18] If these results indicated that the logistic model did not provide an adequate description of the data, we did further analyses, including quadratic and cubic terms for continuous variables in the models. Since a proportion of the Era sample deployed on subsequent Operation TELICs, we repeated the analyses reclassifying these individuals to the Iraq war group. In a planned subgroup analysis, we did similar comparisons with groups stratified by to regular or reservist status. We did a sensitivity analysis to attempt to determine the probable effect of missing data on the principal outcomes.

Our original sample size calculation was done in Epi Info and was based on a need to find differences between cohorts on several outcomes. We used a power of 90% and confidence of 95% (two tailed), and estimated that with 5000 individuals in each cohort we would be able to detect an odds ratio of 1·80 for a disorder such as PTSD with an estimated prevalence of 1% in Era.[19] The corresponding effect size detectable for GHQ was an odds ratio of 1·16 for an outcome such as being a case on the GHQ, with prevalence of cases in the Era sample estimated at 25%.[3] These differences in prevalence were to some extent arbitrary, but indicated that we had sufficient power to detect small differences

in the more common outcome (GHQ cases) and moderate differences in the less common outcome (PTSD). On the basis of our previous experience in tracing military cohorts over longer periods of time than envisaged in the current study,[3,20] we judged that we would achieve a participation rate of 75%, and adjusted the number of participants accordingly. However we increased both cohorts further because increasing numbers of the Era group were being deployed to Iraq, and we also aimed to follow up the sample in the future.

Role of the funding source

The UK Ministry of Defence funded this project. They had no role in the design, analysis, interpretation, or decision to submit this paper. The Ministry of Defence provided us with the names and contact details of potential participants in the study. We disclosed the paper to Ministry of Defence at the point when we submitted it for publication, and any errors of fact identified by the Ministry were corrected at the same time as addressing the comments of reviewers. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

We attempted contact with 17 499 individuals, of whom 10 272 (58·7%) completed the questionnaire and 160 (0·9%) refused to participate. Table 1 shows the response received according to the method of contact we used. For each contact a proportion of questionnaires were returned (return to sender); this proportion varied over the life of the study. The final number of individuals who we can be confident would never have received a questionnaire due to inadequate address information was 657. When these individuals were subtracted from the denominator, the corrected response rate was 61·0%. Further descriptions of participation rates used unadjusted rates.

Table 2 shows the follow-up rates for the entire sample by demographic variable. The table shows that lower response rates were associated with younger age, male sex, being in the Royal Navy or Royal Air Force, not being a commissioned officer, being a reservist, and coming from non-white ethnic background. Participants with civilian addresses, particularly if they were overseas, had lower response rates than those who did not. Finally, deployment status had a slight effect on response rates. We tested for effect modification of every factor in table 2 by deployment status on response rate. The only effect modifier detected was regular or reservist status by deployment status. There was a 5 percentage point difference in response rates between regulars and reserves for TELIC, but a 12 percentage point difference for Era.

On receiving completed questionnaires, we noted that a few respondents assigned to Operation TELIC 1 claimed not to have served on this operation, and some of the Era sample claimed that they did. We used various methods to verify these claims, and checked alternative data sources within the Ministry of Defence. On the basis of these investigations we reassigned 56 individuals from TELIC 1 to Era and 22 individuals from Era to TELIC 1.

The demographic characteristics of the two groups are described in table 3. Although significant differences existed between Era and TELIC for most sociodemographic variables, these differences were generally slight and were attributable to the large size of the sample. Only age and being medically downgraded (which indicates that an individual may not be fit to deploy) were meaningfully different in the two samples.

	Era (n=5550)	TELIC 1 (n=4722)	p*
Age (years) at completion of questionnaire			
<25	796 (15%)	868 (20%)	<0·0001
25–29	919 (17%)	994 (22%)	
30–34	1138 (21%)	1047 (23%)	
35–39	1166 (21%)	896 (19%)	
40–49	1205 (21%)	807 (15%)	
≥50	326 (5%)	110 (2%)	
Sex			
Female	601 (10%)	432 (8%)	0·001
Marital status			
Married/cohabiting	4347 (79%)	3560 (76%)	<0·0001
Single	802 (14%)	864 (19%)	
Previously married	386 (7%)	277 (6%)	
Current occupational status			
Employed in military	4210 (82%)	3629 (84%)	<0·0001
Employed as civilian	1141 (16%)	960 (14%)	
Unemployed/off sick	92 (2%)	68 (1%)	
Retired	35 (1%)	5 (<1%)	
Student	25 (<1%)	26 (1%)	
Educational status†			
No qualifications	456 (9%)	351 (8%)	<0·0001
GCSE or equivalent	2121 (42%)	1969 (45%)	
A level or equivalent	1470 (29%)	1341 (31%)	
Degree or above	1156 (21%)	780 (17%)	
Service			
Royal Navy/Marines	915 (17%)	761 (17%)	0·5
Army	3536 (63%)	3066 (64%)	
Royal Air Force	1099 (20%)	895 (17%)	
Rank (current or last)			
Commissioned officer	1138 (20%)	814 (17%)	<0·0001
Non-commissioned officer	3460 (64%)	2962 (64%)	
Other rank	903 (16%)	904 (20%)	
Health			
Medically downgraded (January, 2003)	615 (13%)	249 (6%)	<0·0001
Enlistment status			
Reservist	800 (8%)	786 (9%)	0·002

Data are number (%) unless otherwise stated. Percentages adjusted to take account of sampling fractions. *Pearson's χ^2 test with Rao and Scott second order correction. Table shows nine comparisons. Using the Bonferroni correction, threshold for statistical significance would be adjusted to 0·006. †GCSEs are examinations taken at age about 16 years; A levels are examinations taken at about 18 years, required for university entrance.

Table 3: **Sociodemographic variables**

	Era	TELIC 1	p*
Northern Ireland (1969–present)	1758 (33%)	1245 (28%)	<0·0001
Falklands war (1982)	238 (5%)	116 (3%)	<0·0001
Gulf war (1990–91)	684 (13%)	662 (15%)	0·02
Northern Iraq/Turkey (1991–2003)	196 (4%)	229 (5%)	0·0001
Bosnia Herzogovinia (1992–present)	1459 (28%)	1231 (27%)	0·6
Kosovo (1999–present)	912 (17%)	1018 (23%)	<0·0001
Sierra Leone 2000	259 (5%)	250 (6%)	0·1
Afghanistan (2001–present)	414 (8%)	666 (15%)	<0·0001
Oman (Saif Sareea 2002)	402 (8%)	703 (16%)	<0·0001
No previous deployment (excluding TELIC 1+ and Saif Sareea)	1908 (31%)	1606 (31%)	0·5

Data are number (%) unless otherwise specified. Percentages adjusted to take account of sampling fractions. *Pearson's χ^2 test with Rao and Scott second order correction. Table shows ten comparisons. Using the Bonferroni correction, the threshold for statistical significance would be adjusted to 0·005. †Saif Sareea was a large-scale exercise in Oman in 2002.

Table 4: **Previous deployments**

Table 4 describes the distribution of past deployments (not including operations related to the Iraq war from 2003 onwards) in the two cohorts. These data indicate that more than two-thirds of participants in both groups had previous experience of deployment. The TELIC 1 group had more experience of other deployments in southwestern Asia (eg, the Gulf War, operations in Northern Iraq and Turkey, the war in Afghanistan and Saif Sareea). Two deployments—Northern Ireland and the Falklands—were more frequently reported by the Era group than the TELIC group.

Table 5 shows potentially traumatic events that were experienced while deployed on Operation TELIC 1 or (for the Era group) on the last major deployment if this happened after 2000. This indicates that most participants on Operation TELIC 1 thought at some point they might be killed and over half came under mortar, Scud missile, or artillery fire. Experiences of seeing people killed or wounded, of handling bodies, and of aiding the wounded were common in this group. These experiences were less common in the Era group, partly because a proportion had no previous experience of deployment, but even when those in the Era group who had no experience of previous deployments were excluded from the denominator, such experiences were less common in the Era group (data not shown).

We compared the main health outcomes according to deployment status (table 6). We noted no differences between groups in the prevalence of common mental disorders, fatigue, and "fair or poor" general health. All the other outcomes were more common in the TELIC 1 group, although these effects were small, with unadjusted ORs ranging from 1·18 to 1·28. After controlling for potential confounders only one variable (having multiple physical symptoms) remained associated with deployment. PTSD using the alternative definition[11] was present in 3% of the Era sample and 4% of the TELIC 1 sample (adjusted OR 1·21; 95% CI 0·96–1·53). In further tables we only report numbers with the conventional definition of PTSD, since there were no meaningful differences in the effect of deployment according to which case definition was used.

Because the effect of deployment might be different for reservists compared with regular forces, and because concerns about the effect of the growing role of reservists had been raised in the UK news media, we planned an a priori subgroup analysis (table 7). Significant interaction terms (between deployment and regular or reservist status) were detected for five of the six outcomes (all except alcohol), indicating effect modification by reservist status. The data shown in table 7 indicate that the results for regulars were similar to those reported overall (table 6). The proportion with multiple physical symptoms was slightly greater in the deployed cohort than in those who were not deployed, but deployment was not related to any other outcomes. By contrast, there was an association between deployment status and most health outcomes for the reservists. Numbers in this group were relatively small, so effect size estimates are imprecise. Common mental disorders and fatigue were significantly more common in TELIC 1 reservists than in Era reservists, and although CIs were wide for other outcomes, ORs suggested that there was a moderate to large potential effect of deployment for reservists for PTSD symptoms, multiple physical symptoms, and general perception of health. These effects seem partly attributable to a higher prevalence of these disorders in the deployed reservists, compared with the deployed regulars. However, each outcome was also less prevalent in the non-deployed reservists than in regulars. Because of the significant interactions reported in table 7, we now focus solely on the health of regulars and will describe the health of reservists in a future paper.

To find out whether the absence of association between deployment and health outcomes for regulars was due to a proportion of the Era cohort having deployed in

	Era (n=4869)	TELIC 1 (n=4721)
Discharged weapon in direct combat	163 (7%)	752 (17%)
Thought might be killed	954 (40%)	2661 (58%)
Came under small arm fire	603 (11%)	1494 (32%)
Came under mortar, SCUD, artillery fire	561 (10%)	2513 (53%)
Experienced landmine strike	85 (2%)	198 (4%)
Experienced hostility from civilians	1153 (22%)	1981 (42%)
Saw personnel killed or wounded (any)	741 (14%)	2140 (45%)
Saw UK/allied forces killed or wounded	481 (9%)	1199 (25%)
Saw enemy forces killed or wounded	220 (4%)	1532 (32%)
Saw civilians killed or wounded	545 (10%)	1291 (27%)
Handled bodies (any)	249 (5%)	736 (15%)
Handled UK/allied forces bodies	120 (2%)	358 (7%)
Handled enemy forces bodies	81 (2%)	486 (10%)
Handled civilian bodies	209 (4%)	466 (10%)
Aided wounded (any)	350 (6%)	883 (18%)
Aided UK/allied forces wounded	270 (5%)	651 (13%)
Aided enemy forces wounded	44 (1%)	458 (9%)
Aided civilian wounded	278 (5%)	702 (14%)

Data are number (%). Percentages weighted to take account of sampling fractions.

Table 5: **Potentially traumatic experiences on last deployment**

subsequent missions to Iraq, we reassigned any Era participants who reported having served on TELIC 2 or subsequent TELIC deployments (table 8). Doing so made no difference to the findings shown in table 7. To assess whether past deployments (especially in the Era sample) disguised a true effect of deployment, we did a further analysis restricted to participants who had no reported previous deployment experience before January, 2003 (table 8). Era individuals who had been deployed on further TELIC deployments after April, 2003, were reassigned to the Iraq war group; hence the Era group (n=1070) in this sample had no experience of major deployments. The Iraq war group (n=1327) was restricted to participants in whom the Iraq war was their first ever major deployment. Alcohol consumption was greater in the Iraq war group than in Era, but this difference did not hold after controlling for sociodemographic variables, especially age. The group deployed to Iraq had a lower prevalence of PTSD symptoms than in the Era group.

Since the end of major combat operations, UK forces have had to contend with continued insurgency, and these later deployments might be responsible for further psychiatric injuries. We therefore redefined the cohort according to the end date the participants gave us for their last deployment to theatre (table 9). These data indicate that there is no clear pattern of increasing psychiatric injuries according to the period when participants were last in theatre, although 95% CI are wide.

Our sample consisted of a wide cross-section of individuals deployed to the Iraq war, who had a range of

	Era*	TELIC 1*	Unadjusted OR (95% CI)	Adjusted OR (95% CI)‡
Common mental disorder (GHQ-12)	1071/5481 (20%)	953/4631 (20%)	1·02 (0·92–1·12)	1·03 (0·92–1·15)
PTSD (PCL-C)	193/5456 (4%)	201/4613 (4%)	1·18 (0·96–1·45)	1·20 (0·95–1·50)
Fatigue case	1685/5466 (31%)	1540/4609 (33%)	1·08 (0·99–1·17)	1·07 (0·97–1·18)
Multiple physical symptoms	546/5550 (10%)	575/4722 (12%)	1·22 (1·08–1·39)	1·33 (1·15–1·54)
Case on AUDIT	1159/5485 (22%)	1183/4637 (26%)	1·28 (1·17–1·41)	1·10 (0·99–1·22)
Fair or poor general health	673/5517 (12%)	537/4658 (11%)	0·89 (0·79–1·01)	1·00 (0·86–1·15)

*Data are number/n (%). Percentages adjusted to take account of sampling fractions. Denominators vary because some participants did not complete relevant questionnaires. †ORs take account of sampling weights. ‡ORs adjusted for age, sex, rank, educational and marital status, service branch, fitness to deploy, and reservist status, and take account of sampling weights.

Table 6: **Distribution of main outcomes by original cohort**

	p*	Reservists			Regulars		
		Era†	TELIC 1†	OR (95% CI)‡	Era†	TELIC 1†	OR (95% CI)‡
Common mental disorder (GHQ-12)	<0·001	128/787 (16%)	206/782 (26%)	2·47 (1·35–4·52)	943/4694 (20·1)	747/3849 (19%)	1·01 (0·90–1·14)
PTSD (PCL-C)	0·02	22/780 (3%)	46/766 (6%)	6·95 (0·89–54·2)	171/4676 (3·7)	155/3847 (4%)	1·17 (0·92–1·48)
Fatigue case	<0·001	214/789 (27%)	315/769 (41%)	1·78 (1·09–2·91)	1471/4677 (31·5)	1225/3840 (32%)	1·06 (0·96–1·17)
Multiple physical symptoms	0·002	66/800 (8%)	120/786 (15%)	2·08 (0·95–4·57)	480/4750 (10·1)	455/3936 (12%)	1·32 (1·14–1·53)
Case on AUDIT	0·7	108/789 (14%)	138/772 (18%)	0·80 (0·44–1·44)	1051/4696 (22·4)	1045/3865 (27%)	1·10 (0·98–1·22)
Fair or poor general health	<0·001	81/798 (10%)	122/781 (16%)	1·54 (0·71–3·35)	592/4719 (12·6)	415/3877 (11%)	0·98 (0·84–1·13)

*Interaction for deployment by regular/reservist status for each outcome. †Date are number/n (%). ‡Adjusted for age, sex, rank, educational and marital status, service branch, and fitness to deploy.

Table 7: **Relation between health outcomes and deployment stratified by regular/reservist status**

	Era*	Iraq war*	Unadjusted OR (95% CI)	Adjusted OR (95% CI)†
Overall				
Common mental disorder (GHQ-12)	774/3714 (21%)	916/4829 (19%)	0·89 (0·80–0·99)	0·91 (0·81–1·02)
PTSD (PCL-C)	135/3698 (4%)	191/4825 (4%)	1·09 (0·87–1·36)	1·00 (0·79–1·28)
Fatigue case	1161/3702 (31%)	1535/4815 (31%)	1·02 (0·93–1·12)	1·04 (0·94–1·15)
Multiple physical symptoms	374/3758 (10%)	561/4928 (11%)	1·16 (1·01–1·33)	1·27 (1·09–1·48)
Case on AUDIT	788/3716 (21%)	1308/4845 (27%)	1·37 (1·24–1·52)	1·09 (0·97–1·22)
"Fair or poor" general health	483/3731 (13%)	524/4865 (11%)	0·81 (0·71–0·93)	0·92 (0·79–1·06)
Participants with no deployments before Jan, 2003				
Common mental disorder (GHQ-12)	226/1055 (21%)	245/1292 (19%)	0·86 (0·70–1·05)	0·83 (0·66–1·04)
PTSD (PCL-C)	51/1051 (5%)	49/1290 (4%)	0·77 (0·52–1·16)	0·61 (0·39–0·95)
Fatigue case	287/1053 (27%)	406/1287 (32%)	1·23 (1·03–1·47)	1·19 (0·97–1·46)
Multiple physical symptoms	85/1070 (8%)	123/1327 (9%)	1·18 (0·89–1·58)	1·35 (0·97–1·88)
Case on AUDIT	231/1054 (22%)	373/1296 (29%)	1·44 (1·19–1·74)	1·03 (0·82–1·29)
Fair or poor general health	115/1056 (11%)	121/1308 (9%)	0·83 (0·64–1·09)	0·90 (0·66–1·22)

*Data are number/n (%). Denominators vary because some participants did not complete relevant questionnaires. †Adjusted for age, sex, rank, educational and marital status, service branch, and fitness to deploy.

Table 8: **Distribution of main outcomes after reassigning Era participants to Iraq war group if they had served in subsequent TELIC deployments (regulars only)**

	Number exposed (% cases)	OR (95% CI)	Adjusted OR (95% CI)†
GHQ-12 cases			
Era	3871 (21%)	1·00	1·00
Iraq war			
TELIC 1	3654 (19%)	0·89 (0·79–0·99)	0·91 (0·81–1·03)
TELIC 2	720 (19%)	0·88 (0·72–1·09)	0·83 (0·67–1·03)
TELIC 3	46 (33%)	1·85 (0·99–3·45)	1·74 (0·91–3·31)
TELIC 4	158 (18%)	0·86 (0·57–1·30)	0·86 (0·56–1·32)
TELIC 5+	94 (23%)	1·17 (0·72–1·90)	1·23 (0·74–2·04)
TELIC ≥3*	298 (22%)	1·09 (0·82–1·44)	1·09 (0·81–1·48)
PCL-C cases			
Era	3861 (4%)	1·00	1·00
Iraq war			
TELIC 1	3643 (4%)	1·05 (0·83–1·32)	0·97 (0·76–1·25)
TELIC 2	719 (3%)	0·79 (0·50–1·24)	0·70 (0·44–1·11)
TELIC 3	46 (2%)	0·55 (0·08–4·04)	0·55 (0·07–4·07)
TELIC 4	158 (3%)	0·65 (0·23–1·77)	0·66 (0·24–1·82)
TELIC 5+	96 (3%)	0·80 (0·25–2·57)	0·61 (0·15–2·53)
TELIC ≥3*	300 (3%)	0·68 (0·33–1·40)	0·63 (0·29–1·36)

TELIC 1: Jan 18 to June 28, 2003. TELIC 2: June 29 to Nov 3, 2003. TELIC 3: Nov 4 to April 28, 2004. TELIC 4: April 29 to Nov 1, 2004. TELIC 5+: Nov 2, 2004, onwards. *Numbers for TELIC 3 or greater combined. †Adjusted for age, sex, rank, educational and marital status, service branch, and fitness to deploy

Table 9: **Effect of date of deployment on mental health outcomes (regulars only)**

different duties. To assess whether there was an association between experience of combat duties and the outcomes under study, we did a further analysis including only those who were deployed to the Iraq war, comparing those with combat duties with the rest (table 10). Combat duties were associated with increased rates of PTSD symptoms and increased alcohol consumption, but were not associated with the other outcomes.

Concerns have been raised that psychiatric symptoms might become increasingly prominent with the passage of time from the end of a deployment.[21,22] For regulars who had served on TELIC, we used the end date of their most recent TELIC deployment and the date when we received their questionnaire to generate a variable which gave time from the end of deployment to the completion of the questionnaire. This time was then categorised into 6-month bands. We noted no significant differences in the prevalence of any outcome by 6-month band. When we controlled for sociodemographic variables and their most recent TELIC deployment, no outcome was significantly associated (table 11). Although prevalence of PTSD apparently increased after 6 months, the OR comparing the proportion with PTSD within 0–5 months with that at 6 months or more since deployment was not significant.

Diagnostic tests of the logistic regression models showed that these were adequate, with the Hosmer-Lemeshow test showing p values of greater than 0·1 for all but three models (AUDIT outcome in regulars [table 7]; AUDIT outcome [table 8]; and multiple physical symptoms outcome [table 10]). In each case, including quadratic and cubic terms for the age variable improved model fit to satisfactory levels (p>0·1), without changing the parameter estimates.

We used three further approaches to investigate the possibility that our findings could be accounted for by non-response bias. The intensive follow-up study was done to find out whether persistent non-responders had particularly high rates of illness. We were able to trace and gain information on current health status for 71 of 147 (48·3%) such non-responders, consisting of ten Era reservists, 29 Era regulars, 13 TELIC reservists, and 19 TELIC regulars. The prevalence of cases of PTSD in this sample was 4% (95% CI 1–12), poor or average general health was 11% (5–21), and self-reported depression on GHQ-12 was 23% (14–34); compared with 24% (23–25) for depression in the main survey.

In the late responder analysis, we calculated the time it took for each participant to return a completed questionnaire after our first attempt at contact. We defined late responders as the highest quartile (>130 days). This variable was not associated with being a case on the GHQ (OR 1·04; 95% CI 0·92–1·16), but was modestly associated with being a case on the PCL-C (1·37; 1·10–1·71). Neither deployment group nor reservist status acted as effect modifiers on these associations.

To assess whether the effects we described for the main outcomes being studied (GHQ and PCL-C cases, table 6) could be accounted for by non-response, we did a sensitivity analysis to calculate the differential non-response needed to produce an odds ratio of 1·5 for the associations between deployment to TELIC and each outcome. Assuming that non-responders in the Era cohort had the same prevalence of the disorder as responders, there would have had to have been a 1·81-fold increase in the expected GHQ case prevalence in the TELIC non-responders compared with TELIC responders to generate an odds ratio of 1·5. Similarly, a 1·84-fold increase in the expected prevalence of PCL-C cases in TELIC non-responders would have been needed to generate an odds ratio of 1·5 for this outcome. For the reservists, we did a further sensitivity analysis based on data shown in table 7. We determined how large the differences in prevalence for non-responders compared with responders would have been, to reduce

	Combat*	Non-combat*	OR (95% CI)	Adjusted OR† (95% CI)
Common mental disorder (GHQ-12)	244/1242 (20%)	539/3129 (19%)	1·05 (0·89–1·23)	1·04 (0·86–1·25)
PTSD (PCL-C)	70/1238 (6%)	97/3125 (3%)	1·87 (1·37–2·56)	1·49 (1·05–2·13)
Fatigue case	414/1236 (34%)	979/3122 (31%)	1·10 (0·96–1·27)	1·05 (0·90–1·23)
Multiple physical symptoms	155/1273 (12%)	359/3152 (11%)	1·08 (0·88–1·32)	1·10 (0·88–1·38)
Case on AUDIT	413/1244 (33%)	770/3128 (25%)	1·52 (1·32–1·76)	1·19 (1·01–1·41)
Fair or poor on general health	132/1259 (11%)	337/3133 (11%)	0·97 (0·79–1·20)	1·05 (0·82–1·33)

*Data are number/n (%). †Adjusted for age, sex, rank, educational and marital status, service branch, and fitness to deploy.

Table 10: **Effect of combat on health (regulars in Iraq war group only)**

	Number/n (% affected)	OR* (95% CI)
GHQ cases		
0–5	111/544 (20%)	1·00
6–11	83/427 (19%)	0·92 (0·65–1·31)
12–17	231/1277 (18%)	0·92 (0·67–1·27)
18–23	95/489 (19%)	1·09 (0·75–1·58)
≥24	327/1753 (19%)	1·08 (0·79–1·49)
0–5 *vs* ≥6	..	0·98 (0·74–1·31)†
PCL-C cases		
0–5	13/543 (2%)	1·00
6–11	17/422 (4%)	1·53 (0·67–3·46)
12–17	40/1269 (3%)	1·20 (0·55–2·63)
18–23	19/490 (4%)	1·73 (0·74–4·04)
≥24	61/1752 (4%)	1·68 (0·78–3·63)
0–5 *vs* ≥6	..	1·50 (0·74–3·05)†

*Adjusted for age, sex, rank, educational and marital status, service branch, fitness to deploy, and most recent TELIC deployment.

Table 11: **Psychiatric morbidity by time elapsed (months) since end of last TELIC deployment (regulars deployed to Iraq war only)**

the observed associations for GHQ and PCL-C cases to an odds ratio of one. For these calculations we assumed that the TELIC non-responders had the same prevalence of disorders as TELIC responders, and varied the prevalence in Era non-responders. A 2·10-fold increase in prevalence of GHQ cases and a 3·00-fold increase in prevalence of PCL-C cases would have been necessary in Era non-responders compared with Era responders to generate an odds ratio of one.

Discussion

This large epidemiological study of UK veterans of the 2003 Iraq war had two principal findings. First, as a whole, individuals who were deployed to Iraq had similar rates of mental and physical illness to a similar military control group who were not deployed to Iraq, the only exception being a slight increase in physical symptoms in those deployed. Second, for most health outcomes we noted significant interaction between deployment and reservist status. Although deployment has not, to date, had any effect on the health of regulars, apart from a slight increase in physical symptoms, which we address in a companion paper,[23] deployed reservists seem worse off than their non-deployed counterparts, an effect that applied to all health outcomes we studied apart from alcohol misuse. Several stresses related to deployment might apply particularly to reservists, related to the civilian life reservists leave behind, such as families and employers not understanding nor supporting their role in the military, and to the military life they join, such as being deployed with unfamiliar units, possibly in roles for which they feel untrained.[24] Furthermore, reservists might be exposed to wider public questioning of the war on their return.

The difference between deployed and non-deployed reservists' health status is also confused by what seems to be unusually good health in reservists who were not deployed (whose rates of all outcomes were lower than those in both groups of regulars). It is therefore possible that beyond the potential confounders that we have controlled, other differences exist between deployed and non-deployed reservists. Reservist status was the only demographic variable we assessed that interacted with deployment with respect to responding to the survey, with non-deployed reservists having a lower participation rate. It is possible that non-deployed reservists who did not complete the questionnaire might have been fearful of being called up, and this fear might be related to poorer health. Our sensitivity analyses show that large differential non-response according to health status would have been necessary to account for the differences we report. The higher rates of physical and mental illness in the deployed reservists are of concern and have important policy implications. Although support from medical and welfare services in theatre is identical, this is not the case after homecoming. During deployment on TELIC 1, reservist families did not have the same welfare services as did the families of regulars.

Turning to the regulars, could there be a true underlying effect that we have failed to detect? With the large sample size we had sufficient power to detect even relatively small effect sizes. The absence of difference between the two cohorts could be accounted for by bias or confounding. We attempted to identify complete cohorts of people serving in Iraq, and although statistically significant differences were noted between the deployed and non-deployed groups in terms of the distribution of sociodemographic variables, the size of these differences was generally slight, and when entered into multivariate analyses they had little effect on the estimated effect sizes. Despite considerable efforts, follow-up was incomplete, and for regulars follow-up in the Era group was less complete than in the TELIC group. However this effect was slight (5 percentage points difference) suggesting that non-participation bias was unlikely to be an important factor. Results of the intensive follow-up study suggested that the prevalence of the main outcomes was similar in persistent non-responders whom we eventually traced, compared with responders, although estimates were imprecise. Our experience of tracing military cohorts is that non-response is mainly caused by difficulties in gaining correct addresses for a highly mobile population[25] and sensitivity analyses indicate that non-response has little effect on findings.[26] The sensitivity analyses in this paper also show that substantial differential response would have to have been present for a genuine finding to have been missed. We suspect that such effects are unlikely, and believe that the results of the late-responder analysis provide further support for this view, since the prevalence of principal outcomes in late responders did not vary according deployment or reservist status.

Another possible bias is the healthy warrior effect, a form of selection bias akin to the healthy worker effect

in civilian occupational groups,[27] whereby adverse effects of employment are disguised, because those employed are, almost by definition, more healthy than the general population. In military studies, the same effect might exist for a single deployment if some of those who would have been deployed are selected out and are therefore reassigned to the non-deployed group.[8] Being medically downgraded was more common in the non-deployed cohort. There were some medically downgraded individuals in the TELIC sample, which indicates that although a downgraded individual may be to some extent unfit, this status does not automatically preclude deployment; some downgraded individuals might be deployed depending on their role and the results of a medical assessment. Controlling for this variable had little impact on effect sizes, suggesting that this form of selection bias was unlikely to explain of our failure to find an effect of deployment in regulars. When analyses were restricted to individuals who had no previous deployment experience, PTSD became less common in those deployed to Operation TELIC. Although this finding might represent a type 1 error, a previous study of UK personnel showed that psychological health can sometimes improve with deployment.[28]

Two US studies[11,12] have now reported on the health of service personnel returning from Iraq. The first study[11] reported considerably higher rates of PTSD measured on the PCL-C, with as many as 20% affected, compared with 4% in our study, using an identical measure and case definition. The second[12] used data from routine screening of US service personnel and found 19% of those returning from Iraq reported mental health problems, as opposed to 11% from Afghanistan, and 9% from other locations. What might account for the differences in prevalence rates between US and UK personnel? First, the earlier US study took personnel from infantry or marine divisions who were (mainly) in combat roles. Our study described a random sample of all UK personnel, and included many who were in combat support (eg, engineers or signals) or combat services support (eg, administrative or nursing services). Although many of these people would have had directly threatening experiences (such as having to take cover from potential mortar attacks or experiencing difficulties while moving between locations), as groups they would have had fewer directly threatening experiences than did people in combat roles. We have shown that people who had a combat role were more likely to have PTSD symptoms and to drink more alcohol than those deployed in other roles, although these effects were relatively small, and do not approach those seen in the US study. However, this difference in role while deployed does not account for the difference between our findings and those of the second US study,[12] which included all military personnel. Second, the groups described in the US studies were demographically different from those described here. The US forces deployed to Iraq in both studies were younger, of lower rank, and contained more reservists than our UK sample. While less than 10% of the US sample had previous experience of deployment,[29] more than two-thirds of the UK service personnel from both cohorts had been on previous deployments in a range of settings, including both war-fighting and peacekeeping duties. They therefore had much more experience of the stresses of military deployments, and might have been more resilient to these stresses. Thirdly, the experience of US personnel deployed in central and northern Iraq entailed greater risk than that experienced by UK forces. US tours of duty are typically for 1 year, whereas UK tours are for 6 months. Although measures of adverse experiences were not identical, 53% of UK personnel reported coming under artillery, rocket, or mortar attack, compared with 86–92% for the studied US forces.[11] However, this difference does not explain the higher rates of PTSD (5%) in the US military assessed before deployment to Iraq compared with the UK forces in our Era sample (3%). Our Era sample—like those deployed to Iraq—were older and had more experience of deployment than their US counterparts, so it is surprising that their rates were not higher than those of the US forces. This finding raises the possibility that cultural and organisational differences might affect reporting of symptoms. For example, the organisation of health care after leaving the services differs substantially between US and UK forces. Our findings also differs from those of a US study[22] that suggested that psychiatric injuries increase in the months after deployment. These results have affected US policy on screening military personnel, but this change in policy is not supported by our results.

We conclude that for regular UK service personnel there is, as yet, no specific health effect of deployment to the 2003 Iraq war and subsequent deployments. However, there are important provisos. First, some individuals will have suffered psychiatric injury as a direct consequence of deployment, although their rates of psychiatric injury are not higher than that of the rest of the UK armed forces. We have not described all health outcomes, and will assess risk-taking behaviours in a separate publication based on the same data. Second, although the aim of our study was to assess health effects of the main war-fighting phase of deployments to Iraq, we have also been able to assess the probable effects of later deployments. Operations in Iraq have now become prolonged. Our data do not suggest that subsequent deployments are associated with increased rates of psychiatric injuries, but the numbers deployed on to these later missions in our study was relatively low, and with time a health effect may become apparent. Third, the possibility of delayed sequelae of deployment cannot be ignored. The 1991 Gulf war was associated with reports of health effects in

the lay media some 2–3 years after the return of troops. Reports of delayed onset of PTSD are controversial, since they might represent genuine incident cases or late presentations of the disorder, but the controversy can only be addressed with longitudinal study designs. We therefore suggest that it is premature to conclude that there has been no effect of deployment to Iraq, and further follow-up is needed.

Contributors

M Hotopf, as a principal investigator, planned, supervised aspects of data collection, did analyses, and wrote the paper. L Hull coordinated the study, and was involved in planning the study and writing the paper. N Fear participated in the planning, conduct, analysis, and writing of the paper. T Browne was involved in data collection and analysis. O Horn was responsible for data management and participated in the planning and conduct of the study. A Iversen participated in the planning and conduct of the study. M Jones participated in the conduct of the research, the analysis, and the writing of the paper. D Murphy participated in the conduct of the research and the writing of the paper. D Bland was involved in data collection and analysis. M Earnshaw, N Greenberg, and J Hacker-Hughes participated in planning of research and was involved with military liaison. R Tate participated in analysis, and provided statistical consultation. C Dandeker, as a principal investigator, sought funding, and participated in planning the research and writing the paper. R Rona, as a principal investigator, sought funding and participated in the planning, supervision of data collection, and writing the paper. S Wessely, as a principal investigator, sought funding, led the planning of the study and supervision of data collection, and made comments on the analysis and writing of this paper.

Conflict of interest statement

M Earnshaw is a member of the Defence Medical Services currently seconded to Kings College London. N Greenberg is a full time active service medical officer who has been seconded to King's College Centre for Military Health Reasearch as a liaison officer; although paid from Ministry of Defence funds he was not directed in any way by the Ministry in relation to this publication. J Hacker-Hughes is a member of the Defence Medical Services currently seconded to King's College London. S Wessely is Honorary Civilian Consultant Advisor to the British Army. All other authors declare that they have no conflict of interest.

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