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Original Contribution

Is Previous Psychological Health Associated With the Likelihood of Iraq War Deployment? An Investigation of the ''Healthy Warrior Effect''

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Using survey data, the authors assessed whether military personnel's prior mental health status would influence their likelihood of being deployed. None of the previous studies that assessed a possible ''healthy warrior effect,'' in which persons selected for deployment have better predeployment health, were based on surveys. A sample of 2,820 United Kingdom military personnel studied in 2002, before the Iraq War, was contacted again between 2004 and 2006. The baseline questionnaire included a measure of psychological distress (the General Health Questionnaire), the PTSD [posttraumatic stress disorder] Checklist (PCL), physical symptoms, and level of medical fitness. A total of 1,885 (67%) participants completed a follow-up questionnaire. General Health Questionnaire caseness in 2002 was associated with a reduction in risk of deployment later on (risk ratio = 0.81, 95% confidence interval: 0.67, 0.99). Scoring high on the PCL intrusiveness and avoidance domains also reduced the risk of deployment. These associations were slightly stronger when the comparison was made between persons who were deployed to Iraq and those who were not. Although risk ratios were well below 1.00, PCL categories were not significantly associated with being deployed. This study demonstrated a small ''healthy warrior effect''; persons with better psychological health had a higher chance of being deployed, even after adjustment for predeployment medical fitness.

bias (epidemiology); follow-up studies; mental health; military personnel; stress disorders, post-traumatic

Abbreviations: GHQ, General Health Questionnaire; PCL, PTSD Checklist; PTSD, posttraumatic stress disorder.

The usual way of assessing the mental health consequences of deployment in military personnel has been to compare those who have been deployed with those who have not (1–4). This comparison relies on the assumption that the psychological health of deployed personnel is similar to that of nondeployed personnel at the point of deployment. It has been argued that comparison between deployed and nondeployed personnel may not be appropriate, because health status before a conflict started may have been worse in nondeployed personnel than in those who were deployed. This may have been an explanation for Gulf War illness, where, despite a significant association in terms of self-reported symptoms, there were essentially null findings for medical admissions and mortality (4–6). Haley suggested that such a lack of impact was due to the ''healthy warrior effect'' (7). Similar concerns exist regarding our United Kingdom-based study about the Iraq War, which found virtually no differences between deployed and nondeployed personnel (2).

Haley, after reanalyzing published data on hospitalizations, argued that reported rates of hospitalization after a conflict in deployed personnel compared with nondeployed personnel should be adjusted for the pattern of hospitalization before the conflict started (7). Such an adjustment was performed by the authors of the original report, but with a different method (5). Haley refers to the systematic differences in the health of military personnel who are deployed to a war zone and those who are not as the ''healthy warrior effect'' (7). This is in fact an extension of the ''healthy worker effect,'' which can accommodate the ''healthy military effect.''

The ''healthy worker effect'' is the bias found in occupational cohort studies, where the apparently better health status of

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workers compared with persons in the general population arises from the increased rate of chronic diseases in persons who are excluded from employment (8). It occurs because relatively healthier persons are more likely to gain employment and to remain employed (9). Turning to the armed forces, persons with poorer mental health might be less likely to enter military service or, if they do, more likely to leave at an early stage of their career (the ''healthy military effect''). The ''healthy warrior effect'' occurs if persons with poorer mental health are excluded from deployment or if elite units, which tend to consist of the most psychologically robust, are deployed in preference to other units.

In a report on US Marines, Larson et al. (10) found greater hospitalization rates for psychiatric disorders, except posttraumatic stress disorder (PTSD), in nondeployed Marines than in Marines deployed to the Iraq and Afghanistan wars. They explained the ''healthy warrior effect'' in their study by a disproportionate number of unfit personnel being in an early phase of training and less likely to be eligible for deployment (10). The use of medical records to investigate the ''healthy warrior effect'' has been criticized for relying on a health-care-seeking population, thus omitting persons with a relevant disorder who do not seek access to health services (11). Stigma and social withdrawal may act as powerful deterrents to the use of health services (12, 13).

To our knowledge, none of the studies that have assessed an impact of the ''healthy warrior effect'' have used survey data. Such a study would be important, because it would shed light on whether a ''healthy worker effect'' is a threat to surveys which are based on comparisons of deployed and nondeployed military personnel, an approach frequently used (2–4, 14, 15). It is uncertain whether the ''healthy warrior effect'' would be a problem in surveys aiming to assess the psychological effects of armed conflicts. The ''healthy warrior effect'' would bias results towards acceptance of the null hypothesis by decreasing the true effect of the psychological consequences of a conflict.

In a prospective study of a representative sample of the United Kingdom Armed Forces, we assessed psychological health in 2002 and deployment status between 2004 and 2006. Some of the personnel assessed in 2002 were subsequently deployed to Iraq; some were deployed elsewhere, and others had not been deployed in the 3 years prior to follow-up. We assessed whether mental health status in 2002 influenced the likelihood of subsequent deployment. Because Haley (7) argued that persons deployed to an armed conflict were fitter than those deployed to another type of operation, we also assessed whether psychological health in 2002 was related to deployment in Iraq as compared with deployment elsewhere. We aimed to test the hypotheses that psychological symptoms prior to the 2003 Iraq War would be negatively associated with being deployed.

MATERIALS AND METHODS

Design and sample

Participants were selected using multistage sampling (16). One hundred units were randomly selected from the 3 branches of United Kingdom military service (Army, Naval Service, and Royal Air Force) by relative strength in July 2001; subsequently, 45 individuals were selected from each of these units. Out of 4,500 service personnel, 2,873 (63.8%) completed the first part of the study in 2002, before preparations for the Iraq War began (16). The strength of the United Kingdom Armed Forces at the outset was 204,180 military personnel. The initial sample corresponded to 2.2% of the total population, and persons who completed the questionnaire corresponded to 1.4% of the population.

Of 2,820 persons who completed the first questionnaire between May and December 2002 and for whom contact details were available, 1,885 (66.8%) completed a second questionnaire between June 2004 and March 2006. Completion of the second questionnaire occurred either during a base visit or by mail. Nonresponders received 2 additional mailings, and persons who had left the armed services were further traced using several national registers (2).

Measures

Predeployment measures of psychological health. We used both a full questionnaire and an abridged questionnaire in 2002, because the initial study was designed to assess whether the use of an abridged questionnaire would improve the response rate (16). The full 2002 questionnaire included the civilian version of the PTSD Checklist (PCL) (17) and the 12-item version of the General Health Questionnaire (GHQ) (18) as a measure of psychological distress and a sample of 15 physical symptoms selected from a previously used questionnaire (4). The abridged 2002 questionnaire included a PCL reduced from 17 items to 14 items, a selection of 4 items from the GHQ following published criteria (''been able to enjoy normal day-to-day activities,'' ''been feeling unhappy and depressed,'' ''been losing confidence in yourself,'' and ''been feeling reasonably happy, all things considered'') (19), and 5 of the 15 physical symptoms (chest pain, pain on passing urine, fatigue, joint stiffness, and pain, without swelling or redness, in several joints). Medical downgrading, which relies on medical officers making an assessment of fitness and employability based on a comprehensive manual, was also ascertained. The classification of employment standards is complex, as it varies by service and trade, but we were able to categorize participants as either downgraded or not downgraded at baseline.

Case status. We used the common items of the 2 questionnaires used in the 2002 survey to maximize the sample for analysis. Psychological distress was defined as a score of 2 or more on the 4-item GHQ. The PCL includes intrusiveness, avoidance/numbing, and hyperarousal items (12). We used overall PCL scores (range, 14–70) and the subscores of the intrusiveness, avoidance/numbing, and hyperarousal items. The PCL score was divided into 4 categories, the highest being a score of 41 or more, which is equivalent to 50 or more on the 17-item PCL—thus a possible PTSD case. The intrusiveness, avoidance, and hyperarousal score distributions were divided a priori into 4 categories to reflect the proportional categories of the full PCL but were changed to 3 because the 2 categories with the highest scores had few subjects (Table 1).

Table 1. Baseline Measures of Psychological Health and Demographic Characteristics of Responders and Nonresponders to Follow-Up, United Kingdom Armed Forces, 2002–2006[a]

	Responders (n = 1,885 or n = 1,859)[b]		Nonresponders (n = 935 or n = 915)[b]	
	No.	% or IQR	No.	% or IQR
GHQ caseness (4-item GHQ)	381	20.2	195	20.9
Physical symptoms	308	16.3	143	15.3
Medical downgrading	228	12.1	122	13.1
PTSD Checklist category (score)				
Group 1 (<25)	1,561	84.0	761	83.2
Group 2 (25–32)	173	9.3	89	9.7
Group 3 (33–40)	78	4.2	34	3.7
Group 4 (>40)	47	2.5	31	3.4
Intrusiveness category (score)				
Group 1 (<9)	1,626	87.5	811	88.6
Group 2 (9–14)	175	9.4	71	7.8
Group 3 (>14)	58	3.1	33	3.6
Avoidance category (score)				
Group 1 (<9)	1,543	83.0	744	81.3
Group 2 (9–14)	236	12.7	126	13.8
Group 3 (>14)	80	4.3	45	4.9
Hyperarousal category (score)				
Group 1 (<8)	1,442	77.5	679	74.2
Group 2 (8–12)	321	17.3	186	20.3
Group 3 (>12)	96	5.2	50	5.5
Service branch				
Army	909	48.2	420	44.9
Naval Service	444	23.6	234	25.0
Royal Air Force	532	28.2	281	30.1
Rank below commissioned officer**	1,460	77.5	771	82.5
Male sex	1,742	92.4	856	91.6
Median age, years*	33	28–38[c]	31	25–37[c]

Abbreviations: GHQ, General Health Questionnaire; IQR, interquartile range; PTSD, posttraumatic stress disorder.

* $P < 0.001$ (t test); ** $P = 0.002$ (chi-squared test).

[a] Except where noted, differences were nonsignificant on the basis of chi-squared tests.

[b] Denominators varied slightly according to the psychological variable considered because not everyone answered all of the questions.

[c] IQR (25th–75th percentile).

Caseness regarding physical symptoms was classified as having at least 3 mild or moderate physical symptoms or at least 1 severe physical symptom from the checklist.

Information was also obtained on sex, age, service branch and rank at baseline, and role in both parent unit and deployed unit at follow-up. Role was categorized as combat, combat support (e.g., engineers and logistic personnel), or combat service support (e.g., catering and medical personnel). Since the kappa statistic for agreement between role in parent unit and role during deployment was good ($k = 0.79$), we used role in parent unit throughout the analyses because it was available for most personnel.

Deployment information. Iraq deployment status was based on information provided by Defence Analytical Services and Advice of the United Kingdom Ministry of Defence and from responses to the self-administered questionnaire. Mismatches between the 2 sources of information were solved on a one-by-one basis. Other deployments were taken as indicated in the self-administered questionnaire. Participants could belong to either the Iraq War group or the era group (in service on March 31, 2003, but not deployed to Iraq). We collected information from the era group about deployment elsewhere. Ethical approval was obtained from the ethics committees of the Ministry of Defence (Navy) and King's College Hospital.

Table 2. Demographic and Service Characteristics of Military Personnel, by Deployment Experience, United Kingdom Armed Forces, 2002 and 2006

	All Personnel (n = 1,885)		Nondeployed (n = 1,007)		Deployed, Non-Iraq (n = 201)		Deployed to Iraq (n = 677)	
	No.	% or IQR	No.	% or IQR	No.	% or IQR	No.	% or IQR
Service branch								
Army	909	48.2	450	44.7	103	51.2	356	52.6
Naval Service	444	23.6	316	31.4	34	16.9	94	13.9
Royal Air Force	532	28.2	241	23.9	64	31.8	227	33.5
Rank below commissioned officer	1,460	77.5	770	76.5	168	83.6	522	77.1
Male sex	1,742	92.4	921	91.5	189	94.0	632	93.4
Role in parent unit								
Combat	268	14.2	156	15.5	29	14.4	83	12.3
Combat support	274	14.5	100	9.9	26	12.9	148	21.9
Combat service support	1,319	70.0	740	73.4	144	71.6	435	64.3
Question not answered	24	1.3	11	1.1	2	1.0	11	1.6
Medically downgraded	228	12.1	143	14.2	17	8.5	68	10.0
Median age, years	33	28–38[a]	34	29–39[a]	33	28–37[a]	31	27–36[a]

Abbreviation: IQR, interquartile range.
[a] IQR (25th–75th percentile).

Analysis. The rationale for the analysis was that a ''healthy warrior effect'' would be probable if psychological health status in 2002 was associated with the likelihood of deployment to Iraq between 2003 and 2006. Logistic regression analyses were performed with the following outcome variables: 1) any deployment (Iraq War plus deployed elsewhere) versus era nondeployed; 2) Iraq War versus era service (deployed elsewhere or nondeployed); and 3) Iraq War versus deployment elsewhere. Measures of health (GHQ, medical downgrading, physical symptoms, and PCL in score categories) were included as independent variables. We used robust between-cluster estimates of variance for cluster-correlated data with baseline units as the clusters (20). Health measures were assessed separately. Results were adjusted for age, rank, sex, service branch, and role in the parent unit, using information from the follow-up questionnaire.

We fitted 3 logistic regression models in each analysis. Model 1 assessed the effect of baseline psychological health in logistic regression analyses adjusted for age, service branch, sex, and rank. Model 2 included the same predictors as model 1, plus medical downgrading to assess whether this variable, known before deployment, would account for any relationship between psychological health at baseline and deployment. Model 3 built upon model 2 by adjusting for role in the parent unit, to check whether any association was due to a specific role in the Armed Forces.

The appropriateness of each model was assessed through the Hosmer-Lemeshow goodness-of-fit test (21). All models were found to be adequate when the PCL and each separate domain were used as categorical variables. We used PCL, intrusiveness, avoidance, and hyperarousal score groups in the analysis. We converted the odds ratios (ORs) into risk ratios (RRs) using the incidence of the outcome (P_o), as $RR = OR/(1 - P_o) + (P_o \times OR)$ (22).

RESULTS

There were no differences between responders and nonresponders in terms of the prevalence of psychological symptoms, medical downgrading, and each of the PCL domains (Table 1). Respondents were older and more likely to be commissioned officers. Median age was lower among persons deployed to Iraq than in the other groups (deployed but not to Iraq or not deployed in the 3 years prior to follow-up) (Table 2). The percentage of deployed personnel was lower in the Naval Service and higher in the Army. The percentage of persons who reported a combat support role was higher in the group deployed to Iraq than in the other groups. Slightly more males than females, in proportion to their strength, were deployed. As expected, more personnel who were medically downgraded in 2002 had not been deployed during the 3 years prior to follow-up.

In model 1, the risk ratio for predeployment psychological distress (4-item GHQ caseness) was lower in persons recently deployed, and this association persisted after additional adjustment for medical downgrading (model 2) and role in parent unit (model 3) (Table 3). The risk ratios for intrusiveness and avoidance, but not those for hyperarousal, were also consistently associated with deployment status in all models. The deployed group was also less likely to have a high score in the intrusiveness and avoidance domains. The association between PCL total score categories and deployment status failed to reach significance ($P = 0.053$) (Table 3).

We carried out similar analyses to assess the ''healthy warrior effect'' among persons deployed to Iraq compared with those in the era group (deployed elsewhere or nondeployed) and among persons deployed to Iraq compared with those who were deployed elsewhere in the 3 years

Table 3. Risk Ratio for Any Deployment Among Military Personnel, According to GHQ Case Status, Physical Symptoms, Medical Downgrading, PTSD Checklist Category, and PTSD Checklist Domain Category at Baseline ($n = 1,835$ or $n = 1,861$)[a], United Kingdom Armed Forces, 2002 and 2006[b]

Health Predictor	Model 1[c]			Model 2[d]			Model 3[e]		
	RR	95% CI	*P* Value[f]	RR	95% CI	*P* Value[f]	RR	95% CI	*P* Value[f]
GHQ caseness (4-item GHQ)	0.78	0.64, 0.95		0.79	0.65, 0.96		0.81	0.67, 0.99	
Physical symptoms	0.98	0.79, 1.21		1.03	0.83, 1.28		1.07	0.86, 1.32	
Medical downgrading	0.69	0.53, 0.90		N/A			N/A		
PTSD Checklist category (score)			0.053			0.101			0.146
Group 1 (<25)	1.00			1.00			1.00		
Group 2 (25–32)	0.74	0.54, 1.00		0.75	0.55, 1.02		0.77	0.57, 1.05	
Group 3 (33–40)	0.74	0.46, 1.17		0.78	0.49, 1.23		0.78	0.49, 1.24	
Group 4 (>40)	0.59	0.32, 1.07		0.62	0.34, 1.13		0.63	0.34, 1.16	
Intrusiveness category (score)			0.023			0.037			0.041
Group 1 (<9)	1.00			1.00			1.00		
Group 2 (9–14)	0.87	0.64, 1.17		0.88	0.65, 1.17		0.88	0.65, 1.18	
Group 3 (>14)	0.46	0.26, 0.82		0.49	0.27, 0.87		0.49	0.27, 0.88	
Avoidance category (score)			0.005			0.011			0.019
Group 1 (<9)	1.00			1.00			1.00		
Group 2 (9–14)	0.66	0.50, 0.86		0.68	0.52, 0.88		0.69	0.53, 0.90	
Group 3 (>14)	0.80	0.50, 1.24		0.84	0.53, 1.31		0.86	0.54, 0.89	
Hyperarousal category (score)			0.311			0.451			0.447
Group 1 (<8)	1.00			1.00			1.00		
Group 2 (8–12)	0.97	0.78, 1.19		0.99	0.80, 1.21		1.01	0.82, 1.25	
Group 3 (>12)	0.73	0.48, 1.10		0.77	0.50, 1.16		0.77	0.50, 1.17	

Abbreviations: CI, confidence interval; GHQ, General Health Questionnaire; PTSD, posttraumatic stress disorder; RR, risk ratio.

[a] Denominators varied slightly according to the psychological variable considered because not everyone answered all of the questions.

[b] Reference group: persons who were nondeployed during the previous 3 years. Some losses occurred because of missing data.

[c] Results were adjusted for rank, age, sex, and service branch.

[d] Results were adjusted for the factors in model 1, plus medical downgrading.

[e] Results were adjusted for the factors in model 2, plus role in parent unit (combat, combat support, or combat service support).

[f] Overall contribution of the categories to the association with deployment status when comparing models with and without the relevant variable.

prior to follow-up (Table 4). Results shown in Table 4 were adjusted for the same covariates as those included in model 3. The pattern of risk ratios in the comparison between persons deployed to Iraq and other personnel was very similar to the pattern shown in Table 3, except that the hyperarousal domain became significant because of a low risk ratio in the group with the highest scores, and the intrusiveness domain became nonsignificant. The avoidance and hyperarousal domains were associated with being deployed to Iraq. The results from models 1 and 2 were very similar to those shown for model 3 in Table 3, with some exceptions. In model 1, the PCL and intrusiveness categories were barely significant ($P < 0.05$) and in model 2 the PCL categories were barely significant ($P = 0.04$), but the intrusiveness categories became nonsignificant ($P = 0.06$).

In the analyses restricted to persons deployed at any time in the last 3 years, there was a tendency for those who had been deployed to Iraq to have better psychological health at baseline than those who were deployed elsewhere, but, with the exception of physical symptoms and hyperarousal categories, these associations were not significant. The results from models 1 and 2 were similar to those from model 3.

DISCUSSION

We have documented a small ''healthy warrior effect'' associated with deployment in relation to psychological

Table 4. Risk Ratio for Deployment to Iraq Among Military Personnel, According to GHQ Case Status, Physical Symptoms, PTSD Checklist Category, and PTSD Checklist Domain Category at Baseline, United Kingdom Armed Forces, 2002 and 2006

Health Predictor	Deployed to Iraq vs. Not Deployed to Iraq[a,b] (n = 1,835 or n = 1,861)[d]			Deployed to Iraq vs. Deployed Elsewhere[b,c] (n = 851–865)[d]		
	RR	95% CI	*P* Value[e]	RR	95% CI	*P* Value[e]
GHQ caseness (4-item GHQ)	0.78	0.63, 0.96		0.82	0.58, 1.13	
Physical symptoms	0.90	0.71, 1.13		0.69	0.48, 0.97	
PTSD Checklist category (score)			0.0608			0.2497
Group 1 (<25)	1.00			1.00		
Group 2 (25–32)	0.74	0.53, 1.02		0.80	0.47, 1.33	
Group 3 (33–40)	0.62	0.36, 1.04		0.48	0.22, 1.02	
Group 4 (>40)	0.67	0.35, 1.26		0.93	0.30, 2.80	
Intrusiveness category (score)			0.0620			0.750
Group 1 (<9)	1.00			1.00		
Group 2 (9–14)	0.88	0.64, 1.19		0.93	0.56, 1.52	
Group 3 (>14)	0.48	0.25, 0.91		0.68	0.23, 1.94	
Avoidance category (score)			0.0047			0.123
Group 1 (<9)	1.00			1.00		
Group 2 (9–14)	0.64	0.48, 0.85		0.71	0.44, 1.10	
Group 3 (>14)	0.72	0.44, 1.16		0.58	0.28, 1.18	
Hyperarousal category (score)			0.0172			0.009
Group 1 (<8)	1.00			1.00		
Group 2 (8–12)	1.03	0.82, 1.27		1.04	0.71, 1.47	
Group 3 (>12)	0.50	0.30, 0.81		0.37	0.19, 0.71	

Abbreviations: CI, confidence interval; GHQ, General Health Questionnaire; PTSD, posttraumatic stress disorder; RR, risk ratio.

[a] Reference group: persons not deployed to Iraq. Some participants were excluded from the analysis because of missing data.

[b] Results were adjusted for rank, age, sex, service branch, medical downgrading, and role in parent unit (combat, combat support, or combat service support).

[c] Reference group: persons who were deployed but not to Iraq. Some participants were excluded from the analysis because of missing data.

[d] Denominators varied slightly according to the psychological variable considered because not everyone answered all of the questions.

[e] Overall contribution of the categories to the association with deployment status when comparing models with and without the relevant variable.

distress (GHQ) and the intrusiveness and avoidance domains of the PCL. The associations remained the same and the hyperarousal domain also became associated in the analysis of persons deployed to Iraq versus other personnel. These associations remained at the same level after adjustment for medical downgrading status before deployment, indicating that we cannot account for a possible bias associated with the ''healthy warrior effect'' in cross-sectional analyses by controlling for this variable. There was a tendency, albeit nonsignificant, for the effect to be associated with deployment to Iraq rather than with deployment to other conflicts. Physical symptom caseness was not associated with deployment, except in the comparison of persons deployed to Iraq with those deployed elsewhere.

If the criterion for assessing a ''healthy warrior effect'' is the presence of a significant association ($P < 0.05$), we would have to concede that there was not a consistent effect throughout the psychological symptom measures. However, the risk ratios were below 1 in most analyses. Although the association between PTSD and the ''healthy warrior effect'' was not significant, it is worth considering that the prevalence of PTSD was low in our study, as in a larger sister study (7); thus, the statistical power for the group with the highest score was low. In relation to physical symptoms, we have reported that the 5-symptom measure has low sensitivity for assessment of unexplained symptoms but high specificity in comparison with measures based on 15 physical symptoms (15).

It is to be expected that in the professional armed forces, rigorous medical examination at entry precludes medically unfit applicants from entering the services, and those admitted are more likely to stay in the services if they maintain their fitness (7). Discussion about the existence of the ''healthy warrior effect'' has been restricted to studies based on hospitalization (including psychiatric hospitalizations)

and mortality (5–7, 10, 23). Larson et al. (10) demonstrated that most psychiatric diagnostic categories, with the exception of PTSD, were more common in nondeployed personnel than in deployed personnel. They inferred that the reason for a ''healthy warrior effect'' would be psychologically unfit personnel being in the early stages of training. Hitherto the ''healthy warrior effect'' had not been demonstrated in surveys. In studies comparing psychological health between deployed and nondeployed personnel, it is customary that persons still in training are not eligible for deployment and thus are excluded from selection. If there was an effect due only to mental health problems early on in the recruitment process, this would not translate into a ''healthy warrior effect'' in most studies. Our results indicate that a ''healthy warrior effect'' in surveys is not restricted to persons in the early stages of military life. Since we adjusted for rank, sex, age, service branch, medical downgrading status, and professional trade, we are fairly confident that our results are not explained by these factors. However, there may be some residual confounding related to the intricate classification of medical downgrading. It is also possible that the classification into 3 combat roles is insufficient to account for fine detail which may be related to mental health. These types of residual confounding are difficult to account for in any survey in a systematic way. It is possible that in some analyses assessing the effect of deployment on psychological symptoms, the researchers may not have found an association or, if an association was found, it could have had a smaller effect size than the true effect because of an underlying ''healthy warrior effect'' bias.

There are several possible explanations for the ''healthy warrior effect.'' One is that the selection of units for deployment may be purposefully made to take into account the difficulty of the operation at hand. The United Kingdom Permanent Joint Headquarters drafts the requirements for an operation in terms of resources and personnel, and the type of unit that matches the level of preparation required for a combat operation could be associated with better psychological health—that is, it could be a proxy for combat readiness and/or being in an elite unit like a Royal Marine or Paratroop regiment. Another explanation is that a person perceived to have a psychological problem in a unit selected for deployment may be left behind because the commanding officer assesses the risk of taking such a person as outweighing any benefit. Haley suggested that in order to ensure comparable deployed and nondeployed populations, the referent population should be restricted to nondeployed military units individually matched with the deployed military units (7). Unfortunately, Haley did not specify the matching criteria for this purpose. In practical terms, such an approach may not be appropriate for the relatively small United Kingdom Armed Forces, as it would be difficult to ensure that the nondeployed group would remain nondeployed during protracted operations. Furthermore, the size and characteristics of units are far from homogeneous in the United Kingdom services, making an appropriate matching procedure difficult. Another possible reason for the ''healthy warrior effect'' could be that persons who had exited the military at the time of completion of the follow-up questionnaire had poorer psychological health than those who remained and were less likely to have been deployed. In our study, 259 (13.8%) participants left the armed services during the study period and 80% of them had not been deployed to Iraq. It is possible that an unknown fraction of persons who left were not deployed because of their imminent release. However, we cannot identify who they were in the group.

Strengths and weaknesses

Our study started, fortuitously, before preparation for the 2003 Iraq War began. With the exception of the Millennium Cohort Study (3), a US study set up to assess how military occupational exposures (including deployment) affect long-term health (3, 13), no other recent large cohort studies have fulfilled this criterion. The response rate of 67% was satisfactory. It is unlikely that our results could be explained by response bias. For such an explanation to be possible, there should have been worse baseline psychological health in the deployed group than in the nondeployed group among nonresponders at follow-up, and this was not the case.

We acknowledge that there were insufficient numbers of possible PTSD cases for analysis. We addressed this limitation by using PCL scores rather than the binary outcome of caseness in the analysis. The results obtained when we used the domain scores of the PCL helped to demonstrate the consistency of our results. Another weakness of the study was related to the low number of participants who were deployed but not to Iraq. This limitation decreased the statistical power to test the hypothesis that there were differences in psychological health between persons deployed to a highly demanding conflict, such as that taking place in Iraq, and persons deployed elsewhere. Lastly, for some subjects, there is a chance that there was an overlap between the baseline assessment and deployment in the previous 3 years as assessed at follow-up. This could have affected the analysis related to any deployments in the last 3 years but not the analysis related to deployment to Iraq, since the war started after the baseline assessment.

Implications

The current study provides an indication that even when effects of deployment on psychological health are not statistically significant, such an effect may have occurred because persons who were deployed may have had a better predeployment level of health than those not deployed. However, this study also showed that the ''healthy warrior effect'' is of low magnitude. Thus, in the discussion of studies assessing the association of psychological symptoms in deployed and nondeployed personnel, it is worth assessing the likely impact of the ''healthy warrior effect.'' At this point in time, the level of commitment of troops in Iraq and Afghanistan is such that it is unlikely we would be able to continue to make a comparison between deployed and nondeployed personnel. It would be reasonable to take into account the range of recent deployments in our analysis to identify deployments that may be associated with poorer psychological health.

In conclusion, our study provides evidence that the ''healthy warrior effect'' may be operating in military studies, but its effect size is small.

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