Health and exposures of United Kingdom Gulf war veterans.
Part I: The pattern and extent of ill health

N Cherry, F Creed, A Silman, G Dunn, D Baxter, J Smedley, S Taylor, G J Macfarlane

Abstract

Objectives—To assess the health of United Kingdom Gulf war veterans, to compare their health to that of similar personnel not deployed, to describe patterns of ill health in both groups, and to estimate their extent.

Methods—Main Gulf (n=4795) and validation Gulf (n=4793) cohorts were randomly selected within strata from the population deployed to the Gulf and a non-Gulf cohort (n=4790) from those who were not sent. Seven years after the war subjects completed a questionnaire about their health in the past month, including 95 symptom questions and two manikins on which to shade areas of pain or numbness and tingling. Responses were subjected to a principal component analysis with rotation and to a cluster analysis within each cohort. Mean symptom score was used as a measure of severity. Areas shaded on the manikins were coded to indicate widespread pain and possible toxic neuropathy.

Results—A response of 85.5% was achieved. Those who had been to the Gulf were more troubled by every symptom with a mean severity score (3.0) substantially greater than in the non-Gulf cohort (1.7). Seven factors were extracted accounting for 48% of the variance. The scores on five factors (labelled psychological, peripheral, respiratory, gastrointestinal, and concentration) were significantly worse in those who had been to the Gulf. Symptoms suggestive of peripheral neuropathy were found more often (12.5%) in the Gulf than the non-Gulf (6.8%) cohorts. Widespread pain was also found more often (12.2% Gulf; 6.5% non-Gulf). Those who had been to the Gulf were found disproportionately (23.8%) in three clusters with high mean severity scores; only 9.8% of non-Gulf respondents were in these clusters. There was no evidence of an important excess in the use of alcohol, tobacco, or referral to hospital specialists by those who had been to the Gulf. For the same level of reported ill health those who had been to the Gulf were less likely to be referred to specialists than non-Gulf veterans.

Conclusion—7 Years after the war, the Gulf war veterans were more troubled about their health than those who had not been sent, with a substantial subgroup reporting a pattern of symptoms suggestive of a significant decline in health.

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Follow up studies of random samples of men and women who served in the Gulf States in 1990–91 have shown—in the United States,[1][2] Canada,[3] the United Kingdom,[4] and Denmark[5]—that veterans report considerably greater ill health than other service personnel. The syndromes identified in Gulf war veterans have been determined by the type of instrument used and the interest of the research team, but have included post-traumatic stress disorders,[1] chronic fatigue syndrome,[4][6] fibromyalgia,[1][7] and multiple chemical sensitivity.[6] Although several studies have considered the possibility of an unusual cluster of symptoms specific to experience in the Gulf, few study designs have had the capacity to investigate this thoroughly, and no novel syndrome has been identified that has been accepted by the scientific community.

The present report describes the pattern of symptoms reported by men and women from the United Kingdom who were sent to the Gulf and those who were not, and assesses the extent to which service in the Gulf was associated with excess ill health.

Methods

The Ministry of Defence (MOD) identified all men and women deployed to the Gulf or Gulf states between September 1990 and June 1991. These personnel were stratified by sex, age (in 5 year groups), service (army, Royal Navy, Royal Air Force), and rank (commissioned officer, other ranks). Each stratum was then matched with a randomly selected sample of equal size from the cohort of personnel in the military forces at 1 January 1991, who were not deployed to the Gulf but whose health, at the most recent medical assessment before the war, would not have prevented that deployment. The complete study cohorts of Gulf and non-Gulf personnel were included in a study of mortality.[8] Because of security risks entailed by contacting subjects, those serving in the special forces were excluded from the present study and thus no conclusion can be drawn about the effects of exposure on their health. Three stratified random samples were then taken, a total of 14 372 men and women. To examine the consistency of results two equivalent cohorts were chosen from those who went to

Centre for Occupational and Environmental Health, University of Manchester, UK
N Cherry
D Baxter
J Smedley

School of Psychiatry and Behavioural Science
F Creed

Arthritis Research Campaign Epidemiology Unit
A Silman
S Taylor

Biostatistics Unit
G Dunn

Unit of Chronic Disease Epidemiology
G J Macfarlane

Correspondence to:
Dr N Cherry, Department of Public Health Sciences, University of Alberta, 13–103 Clinical Sciences Building, Edmonton, Alberta, Canada T6G 2G3
ncherry@ualberta.ca

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Table 1 Response by cohort

| | Gulf | | | | | | Non-Gulf | | Total | |
| | Main | | Validation | | Both | | | | | |
	n	%	n	%	n	%	n	%	n	%
Initial cohort	4795	—	4790	—	9585	—	4787	—	14372	—
Died before contact	40	—	40	—	80	—	38	—	118	—
Long questionnaire	4008	84.3	4077	85.8	8085	85.1	3935	82.9	12020	84.3
Short questionnaire	65	1.4	53	1.1	118	1.2	46	1.0	164	1.2
MAP responder	3	0.1	4	0.1	7	0.1	—	—	7	0.0
Refusal	61	1.3	55	1.2	116	1.2	67	1.4	183	1.3
No contact	618	13.0	561	11.8	1179	12.4	701	14.8	1880	13.2
Total eligible	4755	100	4750	100	9505	100	4749	100	14254	100

the Gulf—a main Gulf and validation Gulf cohort. A non-Gulf cohort was also selected. These study cohorts did not overlap with those in the United Kingdom study already reported[4]; all included here will have been approached eventually as part of a study of reproductive effects, that contact was made only after collaboration with the present study had been completed.

All subjects were given a health questionnaire which sought information on current employment (service or civilian), marital status, deployment to other areas of conflict, attendance at hospital since 1991, and habits (alcohol, tobacco). They were also asked in detail about health during the past month, indicating on an adjacent visual analogue scale, ranging from "not at all" to "very seriously", how much they had been troubled by each of 95 symptoms. The choice of symptoms was made through review of published reports on Gulf war illness, discussion with service personnel who had been in the Gulf, and consideration of illness that might result from exposures—such as pesticides and smoke from burning oil wells—known to have occurred. Subjects were also asked to shade sites of pain (on one manikin) and numbness or tingling (on a second) that had been troublesome in the past month.

Those deployed to the Gulf also completed a second questionnaire giving details of the dates they had been deployed at each location and of exposures that they had experienced while in that area. They were instructed to complete the health questionnaire before beginning that on locations.

Table 2 Response by subject characteristics*

| | Gulf | | Non-Gulf | | Overall | |
	n	%	n	%	n	%
Sex:						
Male	9288	86.3	4641	83.9	13929	85.5
Female	217	89.9	108	80.6	325	86.8
Age at 1 January 1990:						
<20	1381	81.1	688	74.9	2069	79.0
20–4	3312	85.1	1643	80.2	4955	83.5
25–9	2222	86.7	1126	87.2	3348	86.9
30–4	1363	90.2	669	89.4	2032	89.9
≥35	1227	91.0	623	91.2	1850	91.0
Rank:						
Officer	1173	90.1	608	90.6	1781	90.3
Others	8332	85.8	4141	82.8	12473	84.8
Service:						
Army	6665	86.7	3325	83.9	9990	85.8
Navy	1058	82.4	528	79.2	1586	81.3
Air force	1782	87.7	896	86.2	2678	87.2

*From the database supplied by the Ministry of Defence.

Questionnaires were always self completed but the method of administration differed between groups. For those no longer serving the first approach was by post, with discharge addresses supplied by the MOD. For those still serving the approach differed by service. Most of the serving personnel were in the army, and for these, bases were visited in the United Kingdom, Germany, and Cyprus; subjects selected for the study were gathered together to complete the forms in the presence of one of the research team. Such an approach was inappropriate for the navy where service at (or under) sea effectively precluded personal visits. For the air force, where small numbers were spread over many sites, visits by the research team to bases were not planned but one large air force base was included in the site visit to Cyprus. For army personnel not successfully encountered at the site visits and for those in the navy and air force the approach was by post to the service address supplied by the MOD.

Follow up of untraced subjects and non-responders took many forms. For those still serving, telephone contact was made with the base to ensure that the address was correct and that the subject was still stationed there. Where units had moved, the new location was supplied by the MOD. For those in civilian life possible new addresses were obtained through electoral registers, health authorities, and telephone directories. Questionnaires were forwarded by the Driver and Vehicle Licensing Authority (DVLA), by some general medical practitioners, and for a small group of non-responders who had served in the Gulf, the medical assessment programme of the MOD.[9] Where a firm address had been established but the subject had not completed a questionnaire, a telephone contact or home visit was attempted. Where no other option seemed likely to succeed, subjects were asked to complete a shortened form of the questionnaire.

The first site visit was carried out in December 1997, 6.5 years after the end of the Gulf war. Follow up continued until September 1999.

STATISTICAL METHODS
Responses on each 10 cm visual analogue scale were allocated, as a symptom score, to 1 of 21 equally spaced segments. The mean symptom scores overall in both the Gulf and non-Gulf groups were highly skewed, with most respondents reporting little trouble, but the square root of the mean score approximated normality and
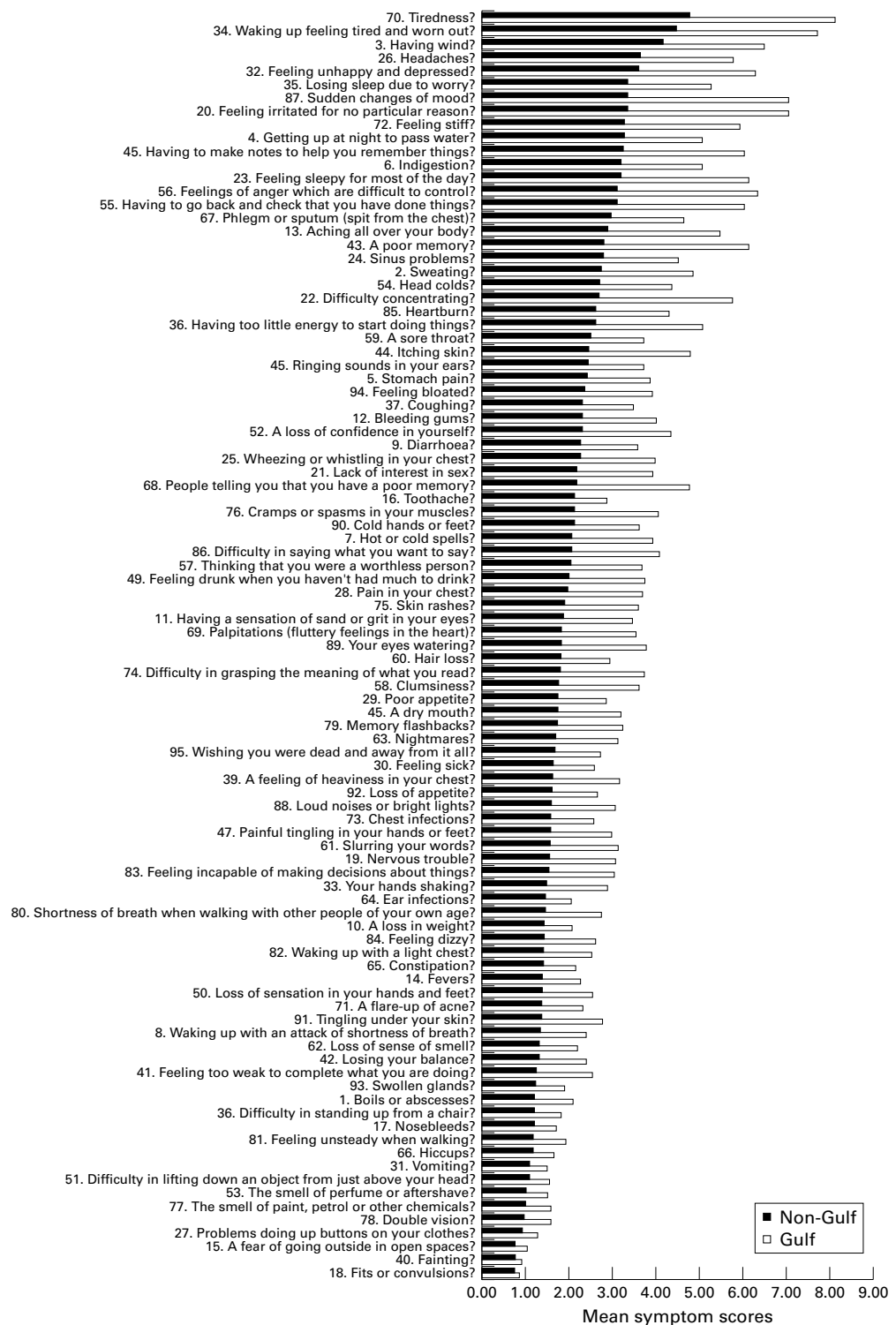
Figure 1   Mean symptom scores in the Gulf and non-Gulf cohorts.

has been used to test significance. Factor scores on seven specific dimensions were derived by principal component analysis (discussed later). With the technique of cluster analysis (discussed later) each respondent was allocated to a group (or cluster) within the same cohort in which the pattern of 95 symptom scores of others in the group were as similar as possible to those of the subject. The size of these clusters was used to estimate the extent to which experience in the Gulf had changed patterns of health.

Areas shaded on the manikin to indicate numbness or tingling were used to define patterns consistent with toxic neuropathy. Possible neuropathy was classified as "limited" if restricted to one or both feet and "extended" if numbness or tingling were reported in both feet and at least one hand or lower leg. Areas shaded to indicate pain (experienced for at

Table 3   Symptoms on which the mean score for Gulf veterans (n=8014) was at least twice that for the non-Gulf cohort (n=3900)

Question number	Symptom	Ratio Gulf/non-Gulf
68	People telling you that you have a poor memory	2.23
43	A poor memory	2.21
22	Difficulty concentrating	2.16
20	Feeling irritated for no particular reason	2.14
87	Sudden changes of mood	2.12
74	Difficulty grasping the meaning of what you read	2.12
58	Clumsiness	2.09
91	Tingling under your skin	2.07
41	Feeling too weak to complete what you are doing	2.07
56	Feelings of anger that are difficult to control	2.05
61	Slurring your words	2.04
83	Feeling incapable of making decisions about things	2.02
86	Difficulty in saying what you want to say	2.01
19	Nervous trouble	2.01

least 24 hours in the past month) were used to define a syndrome of widespread pain present if there were axial skeletal and contralateral body pain.[10]

Principal component factor analysis

The symptom correlation matrix was analysed, with the initial extraction method that of principal components. The varimax procedure was used for rotation, producing a set of orthogonal factor scores, standardised to a mean (SD) of 0 (100). The matrix of weights in the rotated solutions for each of the three cohorts separately were compared by eye in successive analyses, with the extraction of increasing numbers of components. Solutions in which the matrices were judged to be essentially identical in the main and validation cohorts were retained. For each such solution the structure extracted in the Gulf and non-Gulf cohorts were compared, to explore the possibility of a replicable solution in those who had served in the Gulf but not present in the non-Gulf cohort.

Cluster analysis

A k means cluster analysis was used.[11] [12] The non-hierarchical method initially partitioned the respondents into k clusters (k specified by the investigator) with each subject reassigned in turn until an optimal solution was reached in which the distance between cases in different clusters was maximised. This analysis was carried out for the three cohorts separately, with scores from the 95 symptoms. In each case convergence was reached within 200 iterations. The solutions for the three cohorts were again compared by eye, as the number of clusters was increased sequentially. The solution chosen was that with the largest number of clusters in which the pattern of component scores seemed to be essentially the same in the different cohorts.

Validation cohort

The study design, with main and validation cohort selected from those deployed to the Gulf, permitted replication of analyses. Results from each of the Gulf cohorts are given where consistency between cohorts is important in assessing the weight that should be given to the interpretation.

Results

One hundred and eighteen members of the sample died before study contact but of 14 254 surviving, 12 191 (85.5%) completed a questionnaire (table 1). Of these, 164 were short questionnaires and seven were completed through the medical assessment programme; these have been excluded from the main analyses, the short questionnaires because they did not complete comparable symptom data, those completed through the medical assessment programme because there was no equivalent system for contacting sick non-Gulf subjects.

The response was higher for those still serving (5645/6086, 92.8%) than those who had left the forces (6546/8168, 80.1%). Among the non-responders a very high proportion could not be traced to a current address. Although there were only four in the study for whom no address of any sort could be found (two absent without leave from the forces, two thought to be in Northern Ireland where security decreed only a minimal follow up) the address supplied by the MOD for many others proved to be outdated. Among subjects who were contacted to complete the study questionnaire 183 refused but were asked to confirm whether or not they were in good health. Of the 47 willing to provide this minimal information, only one admitted to being unwell.

In the surviving cohort 2.3% were women, 49.3% aged less than 25 years, and 12.5% were officers. The largest numbers were from the army (70.1%) with 18.8% from the air force and 11.1% from the navy. The pattern of response is shown in table 2. The response rate was somewhat lower in those who did not go to the Gulf, particularly in women and those under 25 years. In both Gulf and non-Gulf groups there was a marked increase in response with age. Younger service personnel were more likely to be on a short term engagement and to have left the forces without a pension; tracing in this group was particularly difficult as there was no incentive for them to maintain a current address on MOD records.

SYMPTOMS

A total of 11 914 (99.1%) provided usable answers to at least 90 of the 95 symptoms and have been included in the main analysis. The subject's mean response to all other symptoms was assigned where five or less symptoms had been missed.

The mean score for each symptom is shown in figure 1 by order of decreasing severity in the comparison group. It is evident that symptoms that were rated as particularly troublesome in the non-Gulf group were also rated in much the same order in the Gulf group, with feelings of tiredness being the most troublesome symptom in both groups, and fits or convulsions the least. A rank correlation between mean scores for the 95 symptoms in the Gulf and non-Gulf cohorts exceeded 0.95. On every symptom the score was higher for those who were deployed. However this tendency to report greater severity in the Gulf group was not uniform; for example Q68 (people telling you that they have a poor memory) and Q16 (toothache) had very

Table 4 Analysis of principal components with varimax rotation: weights (≥0.4) assigned on each of seven factors

		Factor*						
		1	2	3	4	5	6	7
3	Having wind					0.541		
5	Stomach pain					0.618		
6	Indigestion					0.701		
8	Waking with an attack of shortness of breath				0.500			
9	Diarrhoea					0.510		
10	A loss in weight							0.529
19	Nervous trouble	0.571						
20	Feeling irritated for no particular reason	0.674						
21	Lack of interest in sex	0.485						
22	Difficulty concentrating	0.601					0.452	
23	Feeling sleepy for most of the day	0.540						
25	Wheezing or whistling in your chest				0.685			
27	Problems doing up buttons on your clothes			0.457				
28	Pain in your chest				0.432			
29	Poor appetite							0.599
30	Feeling sick							0.514
31	Vomiting							0.520
32	Feeling unhappy and depressed	0.761						
34	Waking up feeling tired and worn out	0.598						
35	Losing sleep due to worry	0.640						
36	Difficulty in standing up from a chair			0.571				
37	Coughing				0.677			
38	Having too little energy to start doing things	0.573						
39	A feeling of heaviness in your chest				0.635			
40	Fainting			0.428				
41	Feeling too weak to complete what you are doing	0.441		0.439				
42	Losing your balance			0.549				
43	A poor memory	0.424					0.683	
44	Itching skin		0.572					
45	Having to make notes to help you remember things						0.669	
47	Painful tingling in your hands or feet		0.463	0.437				
50	Loss of sensation in your hands and feet		0.406	0.475				
51	Difficulty in lifting down an object from just above your head			0.572				
52	A loss of confidence in yourself	0.706						
54	Head colds				0.480			
55	Having to go back and check that you have done things	0.457					0.589	
56	Feelings of anger which are difficult to control	0.683						
57	Thinking that you were a worthless person	0.704						
58	Clumsiness	0.442					0.447	
59	A sore throat				0.480			
61	Slurring your words						0.444	
63	Nightmares	0.473						
67	Phlegm or sputum (spit from the chest)				0.651			
68	People telling you that you have a poor memory						0.657	
70	Tiredness	0.566						
71	A flare up of acne		0.410					
72	Feeling stiff	0.401	0.402					
73	Chest infections				0.719			
74	Difficulty in grasping the meaning of what you read						0.544	
75	Skin rashes		0.570					
76	Cramps or spasms in your muscles		0.414					
78	Double vision			0.455				
79	Memory flashbacks	0.462						
80	Shortness of breath when walking with other people of your own age			0.471	0.445			
81	Feeling unsteady when walking			0.661				
82	Waking up with a tight chest				0.649			
83	Feeling incapable of making decisions about things	0.554					0.417	
84	Feeling dizzy			0.489				
85	Heartburn					0.549		
86	Difficulty in saying what you want to say	0.463					0.484	
87	Sudden changes of mood	0.697						
89	Your eyes watering		0.461					
90	Cold hands or feet		0.441					
91	Tingling under your skin		0.533	0.417				
92	Loss of appetite							0.611
94	Feeling bloated					0.408		
95	Wishing you were dead and away from it all	0.639						

*Factor 1=psychological; factor 2=peripheral; factor 3=neurological; factor 4=respiratory; factor 5=gastrointestinal; factor 6=concentration; factor 7=appetite.

similar mean scores (2.1 for both) in the comparison group but in those who had been to the Gulf memory was seen as much more troublesome (with a mean score of 4.8) than toothache (2.8). The 14 symptoms on which the scores for the Gulf cohort were at least twice those for the non-Gulf cohort are shown in table 3.

The difference between the two cohorts in the areas shaded on the manikins suggested that those who went to the Gulf were more likely to experience symptoms consistent with peripheral neuropathy (6.0% limited symptoms, 8.5% extended) than the non-Gulf cohort (4.5% limited, 2.3% extended). The proportion with widespread pain (12.2%) was also higher in the Gulf than in the non-Gulf (6.5%) cohorts.

Mean symptom severity scores were very similar in the main Gulf cohort (3.1) and validation cohort (3.0) but significantly lower in the non-Gulf cohort (1.7) (comparison of means for Gulf and non-Gulf cohorts; p<0.001).

In both Gulf and non-Gulf cohorts lower scores were found in older people (under 25 years 3.3, 25 years or older 2.8), officers (2.0,

Table 5   Mean factor scores by cohort

	Cohort			Contrasts	
Factor	Main (MG)	Validation (VG)	Non-Gulf (NG)	MG v VG	MG+VG v NG
Psychological:					
Mean	12.6	12.9	−26.2	p=0.92	p<0.001
SD	108.8	105.2	77.6		
Peripheral:					
Mean	10.6	10.9	−22.1	p=0.88	p<0.001
SD	110.7	109.6	70.0		
Neurological:					
Mean	−1.2	2.3	−1.1	p=0.16	p=0.39
SD	109.3	112.1	73.2		
Respiratory:					
Mean	5.9	4.2	−10.3	p=0.47	p<0.001
SD	111.5	108.0	75.0		
Gastrointestinal:					
Mean	11.8	8.7	−21.0	p=0.18	p<0.001
SD	108.6	104.7	80.8		
Concentration:					
Mean	10.6	8.4	−20.5	p=0.19	p<0.001
SD	111.5	110.5	67.8		
Appetite:					
Mean	−1.3	−4.5	6.1	p=0.19	p<0.001
SD	114.1	106.2	74.5		
n	3969	4045	3900	—	—

other ranks 3.2) and those still serving (2.7, no longer serving 3.4). Neither marital status at the time of the Gulf nor sex significantly affected symptom scores. Differences in severity score were found between services in both Gulf and non-Gulf cohorts; in the non-Gulf cohort those from the army had a mean score of 2.1, the navy 1.8, and the air force 1.7.

PRINCIPAL COMPONENT ANALYSIS
Principle component analysis (with rotation) was carried out to explore the structure of response to the symptom questionnaire. The analysis was conducted for each of the three cohorts separately and the results obtained by extracting different numbers of factors were examined. The solutions obtained for the main and validation cohorts were similar when up to seven components were extracted and rotated but when more components were extracted the factors differed between Gulf cohorts. In each solution up to seven components the rotated solutions seemed to be essentially the same for the non-Gulf as well as the Gulf cohorts. The analysis was then repeated (table 4) to obtain a single seven factor solution for all three groups together. To facilitate interpretation only questions on which the weight was 0.4 or greater on any of the first seven factors (accounting for 48% of the variance) are shown in table 4. A brief label has been given to each factor: (1) psychological, (2) peripheral, (3) neurological, (4) respiratory, (5) gastrointestinal, (6) concentration, and (7) appetite. These labels are for

identification only and not necessarily of diagnostic significance. Factor 2 was most difficult to name in an informative way; peripheral reflects the skin and neuromuscular complaints weighted most heavily on this factor.

The mean scores on each of these factors are shown for the three cohorts in table 5. The scores for the main and validation Gulf cohorts were very similar with no significant difference on any dimension. There was, however, a clear and significant difference between the Gulf and non-Gulf cohorts in six of the seven factors. Five factors (psychological, peripheral, respiratory, gastrointestinal, and concentration) had higher scores in the Gulf cohorts. One factor (appetite) was significantly lower than in the non-Gulf cohort. No difference was found for the neurological factor, which, as seen in table 4, had high weightings not only on peripheral symptoms but also on symptoms that might arise from poor functioning of the central nervous system.

CLUSTER ANALYSIS
To further assess the impact of service in the Gulf on the health of veterans, a series of cluster analyses was carried out using scores for all 95 symptoms and clustering subjects in each of the three cohorts separately. The aim was not to identify a cluster unique to the Gulf veterans, but to look for common groups of symptoms.

With six clusters a pattern was found that could be interpreted by use of the seven factors from table 4. When each subject was assigned to one of six clusters, the mean scores for each factor were as shown in table 6 with the six clusters arranged in order of decreasing numbers of subjects and increasing overall severity (table 7). The scores were standardised to a mean (SD) of 0 (100); thus from table 6 the mean factor score for psychological ill health for people in cluster 1 was about 0.5 SD below the mean in all three cohorts. The clusters formed independently from the main and validation Gulf cohorts were very similar. The differences between the Gulf and non-Gulf cohorts were greater, particularly on the smaller clusters (4–6).

Cluster 1 was essentially composed of those who were well, with scores appreciably below the mean on five factors and close to the mean on the remaining two. The proportion of the Gulf cohort in this healthy cluster was smaller (36.4%) than the non-Gulf (48.5%) (table 7). Those in cluster 2 (accounting for nearly 30% of each cohort) were also essentially well but with slightly higher symptom scores and

Table 6   Mean factor scores by cluster and cohort

	Cluster 1			Cluster 2			Cluster 3			Cluster 4			Cluster 5			Cluster 6		
Factor	MG	VG	NG	MG	VG	NG	MG	VG	NG	MG	VG	NG	MG	VG	NG	MG	VG	NG
Psychological	−49	−49	−52	−3	−1	−50	138	157	41	−12	−7	−13	133	106	204	141	132	132
Peripheral	−31	−30	−44	8	4	−8	−7	−8	−15	76	62	59	80	112	−17	122	139	68
Neurological	−4	−5	4	−23	−24	−4	−35	−31	−24	−30	−27	−33	37	72	−14	275	306	177
Respiratory	−21	−20	−26	−15	−20	−4	−43	−36	−14	95	93	115	74	74	−33	139	105	66
Gastrointestinal	−37	−41	−54	18	16	−2	24	10	6	89	100	105	77	59	−23	19	32	58
Concentration	−24	−28	−34	9	12	−18	109	85	8	−18	−17	−15	54	55	26	67	81	33
Appetite	−8	−6	−4	−18	−16	11	−19	−12	−1	9	−13	20	11	−3	48	167	145	115

MG=main Gulf, VG=validation Gulf, NG=non-Gulf.

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Table 7 Distribution of cohorts by cluster

Cluster		Cohort							
		Main Gulf		Validation		Non-Gulf		Overall	
Number	Mean severity	n	%	n	%	n	%	n	%
1	1.0	1448	36.5	1469	36.3	1891	48.5	4808	40.4
2	2.6	1104	27.8	1154	28.5	1161	29.8	3419	28.7
3	4.6	462	11.6	458	11.3	462	11.8	1382	11.6
4	5.0	462	11.6	475	11.7	177	4.5	1114	9.4
5	7.7	333	8.4	339	8.4	145	3.7	817	6.9
6	11.7	160	4.0	150	3.7	64	1.6	374	3.1
Overall	3.1	3969	100.0	4045	100.0	3900	100.0	11914	100.0

perhaps more peripheral and gastrointestinal problems. Cluster 3 contained the same proportions of Gulf and non-Gulf veterans but the scores for those in the Gulf cohorts were appreciably higher on the two factors (psychological and memory or concentration) that characterise this cluster. In the remaining clusters those who served in the Gulf war were overrepresented. Thus cluster 4, with high scores on respiratory and gastrointestinal problems, accounted for only 4.5% of the non-Gulf respondents but 11.6% of the Gulf war veterans. In cluster 5, characterised by high scores for psychological ill health in all cohorts but with relatively high scores also for other factors in the Gulf cohort, the proportions from the Gulf cohort were again more than twice as high as in the non-Gulf cohort. Cluster 6, the smallest, contained only 3.1% overall, but again had higher proportions of those who went to the Gulf. Those in this cluster had high symptom scores on all factors with noticeably higher scores on the factor associated with neurological symptoms. Together these three least healthy clusters include 23.8% of the Gulf but only 9.8% of the non-Gulf cohorts.

HEALTH BEHAVIOURS

The proportion of subjects who had been referred to hospital by their general practitioner was high overall with only slightly greater rates in the main Gulf (52.5%) and validation Gulf (51.6%) than in the non-Gulf cohort (49.0%) (difference Gulf/non-Gulf p<0.002). The likelihood of being referred was strongly related, in both Gulf and non-Gulf cohorts, to the symptom cluster, with only 40.6% of those in cluster 1 consulting a specialist but 73.3% of those in cluster 6. It is of note that in the three least healthy clusters (4–6) Gulf veterans were less likely (65.9%) than non-Gulf veterans (73.3%) to be referred by their family physician for specialist investigation or treatment (p=0.005).

The proportion of current smokers was very similar in the three cohorts (36.5% main Gulf, 34.4% validation Gulf, and 33.4% non-Gulf). Only 7.0% of those who went to the Gulf, and 6.7% of those who did not, smoked more than 20 cigarettes a day at the time they were contacted. The proportions who drank more than 20 units of alcohol a week were also comparable, with 17.9% of Gulf war veterans and 16.6% of the non-Gulf cohort reporting this amount.

Discussion

The study reported here was set up to investigate whether there was an excess of ill health among those who went to the Gulf. It is clear that the veterans were more troubled about their health than comparable non-deployed subjects and that these concerns covered a wide range of symptoms. The use of cluster analysis, exploiting similarities rather than differences between the cohorts, allowed estimation of the size of the group affected; the proportion in the three least healthy groups was 14% more in the Gulf than in the non-Gulf cohorts, providing an estimate of about 7500 veterans (of 53 462 deployed) with ill health attributable to the Gulf. Less than half this number have so far presented to the MOD's medical assessment programme.[9] In a recently published and broadly comparable study from the United States,[2] the proportions reporting "functional impairment" (that during the past 2 weeks they had stayed in bed or at home because of ill health) corresponded quite closely to the proportions in the three least healthy clusters in the present study. Among the United States Gulf veterans 27.8% reported impairment compared with only 14.2% of non-Gulf veterans.

Interpretation of these data is not easy, particularly in the absence of objective measures of the prevalence of conditions—such as peripheral neuropathy—which might plausibly result from exposures in the Gulf. Previous studies in the United States have not found an increase in mortality[13] or hospital admissions of Gulf War veterans[14 15] and in the present cohort, those who had been to the Gulf were no more likely to have died.[8] Although there was no marked increase in the proportions who had been referred to specialist physicians, the lower referral rate for Gulf than non-Gulf veterans in the three least healthy clusters suggest that, in the United Kingdom, any increase in morbidity was being managed largely within primary care. In the most comparable United States study,[2] more visits to a clinic during the previous year were recorded by Gulf (51%) than non-Gulf (41%) veterans. In the present study the greater psychological and other concerns in Gulf war veterans do not seem to be translated into higher rates of cigarette smoking or drinking of alcohol, which would lead to an excess of chronic ill health.

Although this lack of an excess in signs of severe morbidity is reassuring, there is nevertheless clear evidence, consistent across the cohorts, that among those who went to the Gulf there are substantial subgroups who feel unwell. Such ill health has been reported after previous conflicts[16] and it may be that this reflects changes in perception resulting from disruptions of war rather than specific chemical, physical, infective, or psychological exposures. The hypothesis that exposures during deployment contributed to the ill health of United Kingdom Gulf war veterans is investigated in part II of this paper.[17]

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Open reviewing

Many journals, including the BMJ, have moved to a system of open reviewing, whereby authors know the names of reviewers of their papers. Research has shown that named reviews, although not of better quality than anonymous reviews, are not of worse quality either. Therefore in the interests of transparency, it seems fair to let authors know who has reviewed their paper. At *Occupational and Environmental Medicine* we have considered the issue carefully. There are some concerns that reviewers, especially those who are more junior, might feel intimidated and not wish to make negative comments about papers submitted by senior people in the field. On the other hand, some reviewers might hide behind the cloak of anonymity to make unfair criticisms so as to reduce the chances of publication by rivals. We have decided to introduce initially a system of open reviewing if the reviewers agree explicitly. So when a reviewer is sent a paper, he or she is asked to indicate whether we can disclose their name or not when sending the authors their comments. We will be monitoring this to see how many of our reviewers are happy to be named. If it is most of them, we will move to a system of open reviewing as the norm, with a possible "opt out" clause for reviewers.