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Self-reported ill health in male UK Gulf War veterans: a retrospective cohort study

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Abstract

Background: Forces deployed to the first Gulf War report more ill health than veterans who did not serve there. Many studies of post-Gulf morbidity are based on relatively small sample sizes and selection bias is often a concern. In a setting where selection bias relating to the ill health of veterans may be reduced, we: i) examined self-reported adult ill health in a large sample of male UK Gulf War veterans and a demographically similar non-deployed comparison group; and ii) explored self-reported ill health among veterans who believed that they had Gulf War syndrome.

Methods: This study uses data from a retrospective cohort study of reproduction and child health in which a validated postal questionnaire was sent to all UK Gulf War veterans (GWV) and a comparison cohort of Armed Service personnel who were not deployed to the Gulf (NGWV). The cohort for analysis comprises 42,818 males who responded to the questionnaire.

Results: We confirmed that GWV report higher rates of general ill health. GWV were significantly more likely to have reported at least one new medical symptom or disease since 1990 than NGWV (61% versus 37%, OR 2.7, 95% CI 2.5–2.8). They were also more likely to report higher numbers of symptoms. The strongest associations were for mood swings (OR 20.9, 95%CI 16.2–27.0), memory loss/lack of concentration (OR 19.6, 95% CI 15.5–24.8), night sweats (OR 9.9, 95% CI 6.5–15.2), general fatigue (OR 9.6, 95% CI 8.3–11.1) and sexual dysfunction (OR 4.6, 95%CI 3.2–6.6). 6% of GWV believed they had Gulf War syndrome (GWS), and this was associated with the highest symptom reporting.

Conclusions: Increased levels of reported ill health among GWV were confirmed. This study was the first to use a questionnaire which did not focus specifically on the veterans' symptoms themselves. Nevertheless, the results are consistent with those of other studies of post-Gulf war illness and thus strengthen overall findings in this area of research. Further examination of the mechanisms underlying the reporting of ill health is required.

Background

Following the 1990–91 Gulf War there have been a number of published reports highlighting the increased morbidity of military personnel who served in the conflict. Studies from all over the world show that forces deployed to the Gulf (GWV) report more ill health than

veterans who did not serve there (NGWV) [1-7]. In terms of the *types* of reported symptoms, different studies have discovered a range of nonspecific chronic conditions. Many research groups have noted that GWV are more likely to suffer from substantial fatigue, symptoms of post-traumatic stress, and psychological distress [1,2,4]. Others have also described peripheral, respiratory, gastrointestinal, psychological and concentration problems [3].

Despite millions of dollars of funding and several independent investigations in a number of countries [8], the increased morbidity of GWV remains an unexplained phenomenon. Media interest and anecdotal reports have fuelled speculation concerning the existence of a Gulf War syndrome (GWS), linking reports of ill health to certain hazardous exposures experienced during the conflict. Most notably these include anti-chemical warfare nerve agent prophylaxis (NAPS), depleted uranium, multiple vaccinations, smoke from oil fires and pesticide use. It is hypothesised that exposure to these hazards has led to the development of a unique syndrome among some GWV, including symptoms of post-traumatic stress disorder [4], fibromyalgia [9], chronic fatigue [1,10] and multiple chemical sensitivity [10,11]. However, attempts to specify and measure the syndrome have led to contradictory findings and interpretations [12]. Current opinion does not support the existence of a unique syndrome affecting GWV, but findings support an excess of non-specific self-reported ill health in this group [13,14].

This is the largest UK study of post-Gulf War morbidity to date, and the first to approach all veterans of the Gulf war (rather than a sample), including both serving and discharged personnel. The questionnaire focused on reproduction and child health, but a page was included which asked for information on the study participants' changes in health status since 1990. Since the focus of the study was on reproduction and child health, we reasoned that selection bias relating to the ill health of the veterans themselves might be reduced. Previous studies have included tick-boxes or grading scales with a list of possible symptoms for respondents to mark and GWV have tended to report increased frequencies of almost all symptoms included in questionnaires [1,3,4]. In contrast, we asked participants to respond to an open-ended question about 'any new medical problems or changes in general health since 1990'. By allowing veterans to report on a full and non-specific range of symptoms using free text it was hoped that they would report only those symptoms which they felt were most important to them.

The main objective of this analysis was to quantify and describe symptoms and diseases reported by UK GWV and a comparison group since 1990. We aimed to determine whether GWV still report more ill health, and/or a different profile of symptoms and diseases than NGWV when, i) their children's rather than their own health was the focus of the study; and ii) details of their own ill health were requested in a non-specific way using free-text. In addition, we aimed to estimate the number of GWV who believed that they had Gulf war syndrome (GWS), and to compare their reported disease/symptom profiles with GWV who did not believe they had the syndrome.

Methods

Full details of the study are reported elsewhere [15]. In brief, the Gulf War cohort (GWV) consisted of all UK armed forces personnel deployed to the Gulf area at any time between August 1990 and June 1991 (51,581 men and 1,230 women). Special forces were excluded for security reasons. The comparison cohort (NGWV) comprised demographically similar personnel who were in service on 1st January 1991 and were appropriately fit, but were not deployed to the Gulf (51,688 men and 1,236 women). The group was stratum-matched on sex, age (five-year groups), service (Army, Navy, Air Force), rank (officer, other ranks), serving status at the time of the Gulf War (regular, reservist) and on fitness to be deployed (Army and Air Force only). 42,818 men and 1,269 women responded to the survey, representing response rates of 48% and 66% respectively after adjusting for undelivered mail. For reasons of statistical power, the analyses reported in this paper were restricted to the 42,818 male responders.

Basic demographic details and last known address for all surviving cohort members were obtained from the Ministry of Defence (MoD). Information was collected using a validated postal questionnaire sent to both serving and discharged military personnel between August 1998 and March 2001. In addition to questions on reproduction and pregnancy outcome, information was collected on the study participant's current health, and on changes in health status since 1990. Questions on service history, smoking status, current alcohol consumption, and details of vaccinations and exposure to specific chemical and environmental factors during the Gulf war (1990–91 for NGWV) were included. GWV were also asked if they considered that they had 'Gulf War syndrome' (Yes /No/Not Sure). Missing information was checked by letter or telephone, and an Intensive Tracing Study (ITS) of non-responders was conducted.

The primary outcome measure was the reporting of one or more new medical problems or changes in general health since 1990. Reported symptoms/diseases were coded into one of 36 different categories (based loosely on ICD-10 classification), and the data were examined by these ill health categories. Subjects were counted only once in the

analysis if they had more than one symptom in the same category.

Statistical analysis

All analyses were performed using Stata 7.0 statistical software [16]. All p-values quoted are two-sided and values less than 0.05 were taken to indicate statistical significance. t-tests were conducted on log transformed data to compare the average number of ill health categories reported per subject in different groups. The association between deployment and ill health was explored using logistic regression analysis, calculating odds ratios and 95%CIs (with NGWV as baseline) for each ill health category. We adjusted for age at survey, service, rank, serving status at time of survey, smoking status and current alcohol consumption in all models.

Results

Response

Data supplied by all male respondents are analysed here (24,379 GWV; 18,439 NGWV). Characteristics of these men and of those reporting one or more medical problems arising since 1990 are presented in Table 1. GWV responders were slightly younger than NGWV responders, and were more likely to have served in the Army, to *not* be an officer, to have left the Armed Services, to have ever smoked, and to have consumed larger amounts of alcohol. However, the differences in the distributions were not large. Among those reporting one or more medical symptom/disease, GWV were again younger, more likely to serve in the Army, to *not* be an Officer, and to have ever smoked.

Symptoms/diseases

61% of GWV reported at least one new medical symptom since 1990 compared with 37% of NGWV (adjusted OR 2.7, 95% CI 2.5–2.8). The data are presented by ill health category in Table 2 in order of frequency of reporting by GWV (highest to lowest). The most common symptoms/diseases reported by GWV were skeletal and other muscular symptoms (15.1%), 'other' symptoms (13.1%), general fatigue (10.8%), memory loss/lack of concentration (7.9%) and skin allergies (7.6%). Accidental injury (2.6%) was among one of the most common ill health categories reported by NGWV. Overall, GWV reported significantly more symptoms/diseases than NGWV. Among all those reporting one or more new symptom/disease since 1990, GWV reported a median of two different ill health categories per subject (range 1–23), while NGWV reported a median of one (range 1–17) ($p < 0.001$).

For over 85% of categories of ill health, symptom/disease prevalence was higher among GWV (Figure 1; Table 2). Strongest associations with Gulf war service included mood swings (OR 20.9, 95%CI 16.2–27.0), memory loss/lack of concentration (OR 19.6, 95% CI 15.5–24.8), night sweats (OR 9.9, 95% CI 6.5–15.2), general fatigue (OR 9.6, 95% CI 8.3–11.1) and sexual dysfunction (OR 4.6, 95%CI 3.2–6.6). Adjustment for potential confounding factors had little impact on these associations, none changing the ORs by more than about 3–4% on average.

Gulf War syndrome (GWS) among GWV

23,103 GWV answered the question "Do you consider that you have "Gulf War Syndrome"?". 5.6% believed that they had the syndrome (GWS) and 40.9% stated that they were 'unsure' (Table 1). Among all GWV reporting one or more new symptom/disease since 1990, veterans who believed that they had GWS reported the highest number of different symptoms/diseases (median = 3; range 1–23), with those who were unsure (unsure-GWS) reporting more symptoms/diseases (median = 2; range 1–15) than those who stated that they did not (non-GWS) (median = 1; range 1–10 categories per subject); (χ^2_{trend}: $p < 0.001$). For all but one ill health category (accidental injury), those who believed that they had GWS reported the highest symptom/disease prevalence, with unsure-GWS reporting intermediate frequencies for all categories (Table 3; Figure 2).

Discussion

This is the largest study of male UK veterans of the first Gulf war and the only one to approach all those deployed. Unlike other Gulf war studies, information on ill health arising since the war was collected using free text. Our study confirmed that GWV were significantly more likely to report at least one new medical problem since 1990 than a non-deployed comparison group. It also confirmed that veterans were more likely to report higher numbers of symptoms/diseases. These typically included skeletal and other muscular symptoms, general fatigue, memory loss/lack of concentration, skin allergies, mood swings/aggression and headaches. This pattern of symptom reporting is similar to that found in other studies of UK GWV [1-3], which looked at the same populations using different methods. For example, Unwin *et al* [1] found that GWV reported *all* symptoms (in pre-defined categories) at higher frequencies than NGWV in their study of a sample of UK veterans with two matched comparison groups, while we found that GWV reported higher prevalence in 85% of ill health categories.

In terms of the nature of self-reported ill health, we found similar results to the range of symptoms that have been reported elsewhere. Gray *et al's* [17] study of GWV found that over 50 percent of diagnoses could be classified into four large categories: diseases of the musculoskeletal system and connective tissue (19.0%), mental disorders (14.7%), diseases of the respiratory system (10.5%) and diseases of the skin and subcutaneous tissue (9.4%). In

Table 1: Characteristics of all male responders, and of those reporting one or more new medical symptom since 1990

Variable	ALL MALE RESPONDERS[1]		MALE RESPONDERS REPORTING ≥ 1 NEW MEDICAL SYMPTOM/DISEASE SINCE 1990[1]	
	GWV n (%)	NGWV n (%)	GWV n (%)	NGWV n (%)
Total	24,379 (100)	18,439 (100)	14,411 (100)	6,670 (100)
Age at time of survey (years)				
20–29	5,506 (23)	3,442 (19)	3,361 (23)	1,295 (19)
30–34	7,871 (32)	5,754 (31)	4,523 (31)	1,951 (29)
35–39	5,492 (23)	4,399 (24)	3,222 (22)	1,462 (22)
40–44	3,019 (12)	2,500 (14)	1,797 (13)	943 (14)
≥45	2,491 (10)	2,343 (13)	1,508 (11)	1,019 (15)
Mean (SD)	*35(6.8)*	*36(7.3)*	*35(6.8)*	*36(7.9)*
Service at time of Gulf War[2]				
Army	17,106 (70)	12,559 (68)	10,619 (74)	4,750 (71)
RN	2,417 (10)	2,110 (11)	1,227 (9)	658 (10)
RAF	4,856 (20)	3,770 (21)	2,565 (18)	1,262 (19)
Rank at time of Gulf War[2]				
Officer	3,202 (13)	3,062 (17)	1,616 (11)	1,068 (16)
Other ranks	21,177 (87)	15,377 (83)	12,795 (89)	5,602 (84)
Serving status at time of survey				
Still serving	13,259 (54)	10,553 (57)	7,293 (51)	3,366 (51)
No longer serving	11,120 (46)	7,886 (43)	7,118 (49)	3,304 (50)
Smoking				
Ever	13,514 (57)	9,716 (54)	8,468 (59)	3,784 (57)
Never	10,390 (44)	8,379 (46)	5,865 (41)	2,870 (43)
Alcohol intake at time of survey (units per week)				
None	1,514 (7)	1,190 (7)	1,056 (8)	531 (8)
1–3	3,269 (14)	2,377 (13)	2,093 (15)	1,002 (15)
4–10	8,838 (38)	6,848 (39)	5,169 (37)	2,398 (37)
11–20	6,173 (26)	4,767 (27)	3,548 (25)	1,638 (25)
≥21	3,632 (16)	2,538 (14)	2,180 (16)	958 (15)
"Gulf war syndrome"				
Yes	1,324 (6)		1,282 (9)	
No	12,577 (53)	-	4,925 (35)	-
Not sure	9,692 (41)	-	8,041 (56)	-

[1]Numbers for each variable might not add up to total due to missing values. [2]At 1st January 1991, or at time of first deployment if known (GWV responders).

our study the same four categories accounted for 50.3 percent of all reported symptoms/diseases and this figure rises to over 70 percent when the categories of fatigue and nervous system disorders are included. An additional point concerns the higher levels of accidental injury reported by NGWV veterans; accidents were only half as likely to occur among GWV compared to NGWV (1.3% versus 2.6%). This was surprising as mortality from accidents has repeatedly been found to be raised among GWV [18]. This difference is probably due to the inclusion of both major and minor injuries (including those resulting in bone fractures) in our study, and because GWV may be more inclined to report things they think are associated with their Gulf War service.

Our findings on Gulf War syndrome (GWS) approximate those from other studies [12-14,19,20]. A significant proportion of GWV believed that they had GWS (5.6%) and this belief was associated with increased symptom reporting. This figure was lower than that reported by other studies (Chalder *et al* [12] found that 17.3% of GWV believed that they had GWS), but we are the first group to report on a large proportion of GWV who were 'unsure' of their GWS-status (40.9%). 'Unsure' veterans generally reported intermediate frequencies of ill health between those veterans who believed that they had GWS and those that did not. In a sample of UK veterans, Chalder *et al* [12] found that those who believed they had GWS were more fatigued, more distressed, and more likely to have a post-traumatic stress reaction than veterans who did not believe they suffered from GWS. Our data showed that GWS veterans reported higher frequencies of all categories of ill health (except accidental injury), including skeletal and other muscular symptoms, general fatigue, mood

Table 2: Summary of self-reported symptoms/diseases by deployment (ordered by frequency of reported ill health categories among GWV)

Self-reported symptom	Frequency (%) GWV[1] (n = 23,358)[2]	NGWV[1] (n = 17,730)[2]	GWV vs. NGWV Adjusted odds ratio [3] (95% CI)
All reporting ≥ 1 new symptom/disease since 1990	**14,174[2] (60.7)**	**6,505[2] (36.7)**	**2.7 (2.5–2.8)*** **
Mental and behavioural disorders	**4,691 (20.1)**	**634 (3.6)**	**6.7 (6.1–7.3)*** **
Memory loss / lack of concentration	1,883 (7.9)	76 (0.4)	19.6 (15.5–24.8)***
Mood swings / aggression / irritability	1,712 (7.3)	62 (0.4)	20.9 (16.2–27.0)***
Anxiety / stress / sleep disturbance	1,212 (5.2)	272 (1.5)	3.4 (3.0–3.9)***
Depression	1,005 (4.3)	203 (1.1)	3.6 (3.1–4.2)***
PTSD and associated symptoms (mentioned specifically)	231 (1.0)	68 (0.4)	2.4 (1.8–3.1)***
Sexual dysfunction / lack of sex drive	192 (0.8)	35 (0.2)	4.6 (3.2–6.6)***
Other psychiatric / psychological disorders NOS[4]	380 (1.6)	65 (0.4)	3.9 (3.0–5.1)***
Musculo-skeletal & connective tissue disorders	**3,807 (16.3)**	**2,387 (13.5)**	**1.2 (1.2–1.3)*** **
Skeletal & other muscular symptoms	3,523 (15.1)	2,346 (13.2)	1.1 (1.1–1.2)***
Muscular pain / weakness (mentioned specifically)	460 (2.0)	77 (0.4)	4.5 (3.5–5.7)***
Other symptoms NOS[4]	**3,058 (13.1)**	**1,146 (6.5)**	**2.2 (2.0–2.3)*** **
Fatigue	**2,632 (11.3)**	**236 (1.3)**	**9.1 (8.0–10.5)*** **
General fatigue	2,532 (10.8)	215 (1.2)	9.6 (8.3–11.1)***
Chronic fatigue syndrome / ME (mentioned specifically)	100 (0.4)	21 (0.1)	3.5 (2.1–5.5)***
Nervous system disorders	**2,104 (9.0)**	**435 (2.5)**	**3.8 (3.4–4.2)*** **
Headaches	1,554 (6.7)	280 (1.6)	4.2 (3.7–4.8)***
Numbness / tingling / dizziness	460 (2.0)	93 (0.5)	3.6 (2.9–4.6)***
Epilepsy	53 (0.2)	21 (0.1)	1.6 (1.0–2.7)
Other neurological and neuromuscular problems NOS[4]	217 (0.9)	68 (0.4)	2.4 (1.8–3.1)***
Infection	**1,898 (8.1)**	**606 (3.4)**	**2.5 (2.3–2.7)*** **
Chronic / frequent infection	1,351 (5.8)	278 (1.6)	3.8 (3.3–4.3)***
Single episodes of acute infection	635 (2.7)	351 (2.0)	1.4 (1.2–1.6)***
Skin allergies	**1,782 (7.6)**	**414 (2.3)**	**3.3 (3.0–3.7)*** **
Respiratory disorders	**1,468 (6.3)**	**569 (3.2)**	**2.0 (1.8–2.2)*** **
Asthma	608 (2.6)	374 (2.1)	1.2 (1.1–1.4)**
Respiratory problems NOS[4]	898 (3.8)	204 (1.2)	3.3 (2.9–3.9)***
Digestive, stomach & intestinal disorders	**1,377 (5.9)**	**538 (3.0)**	**2.0 (1.8–2.2)*** **
Deterioration in general health	**852 (3.7)**	**510 (2.9)**	**1.3 (1.1–1.4)*** **
General deterioration of eyesight / hearing	582 (2.5)	465 (2.6)	1.0 (0.8–1.1)
General decline in fitness / health	280 (1.2)	48 (0.3)	4.4 (3.2–6.0)***
Cardiovascular disorders	**675 (2.9)**	**442 (2.5)**	**1.3 (1.1–1.4)*** **
Endocrine, nutritional and metabolic disorders	**624 (2.7)**	**210 (1.2)**	**2.2 (1.9–2.6)*** **
Hormonal imbalance / problems	70 (0.3)	38 (0.2)	1.5 (1.0–2.2)
Diabetes	57 (0.2)	64 (0.4)	0.7 (0.5–1.0)
Weight gain / loss	504 (2.2)	109 (0.6)	3.4 (2.7–4.1)***
Genito-urinary system disorders	**464 (2.0)**	**198 (1.1)**	**1.8 (1.5–2.1)*** **
Genital system & bladder problems[5]	276 (1.2)	99 (0.6)	2.2 (1.7–2.7)***
Kidney disease / symptoms	209 (0.9)	103 (0.6)	1.5 (1.2–1.9)**
Chest pains / tightness (not elsewhere classified)	**399 (1.7)**	**134 (0.8)**	**2.2 (1.8–2.6)*** **
Allergies other than skin	**369 (1.6)**	**161 (0.9)**	**1.8 (1.5–2.1)*** **
Night sweats / excessive sweating / "fevers"	**315 (1.4)**	**23 (0.1)**	**9.9 (6.5–15.2)*** **
Accidental injury	**294 (1.3)**	**460 (2.6)**	**0.5 (0.4–0.5)*** **
Auto-immune disease	**241 (1.0)**	**196 (1.1)**	**1.0 (0.8–1.2)**
Cancer[6]	**127 (0.5)**	**88 (0.5)**	**1.1 (0.9–1.5)**

[1]Subject can appear in the table as many times as they reported different symptoms. More than one symptom within a group in the same subject counted once only. Number of symptoms in sub-groups may not add up to group total if more than one symptom was recorded within the group for the same subject. [2]Denominators and number of veterans reporting ≥ 1 new symptom/disease since 1990 are different to the numbers reported in Table 1 as some respondents did not give specific details of their symptoms/diseases and could not therefore be included in this table. [3]Adjusted for age at survey, service and rank at time of Gulf war, serving status at time of survey, alcohol consumption and smoking. [4]Not Otherwise Specified (NOS) [5]Category includes those reporting 'burning semen' GWV 13 (0.1%); NGW 1 (0.0%) [6]Includes all reported malignant neoplasms, plus all reported brain tumours, benign or malignant. * 0.01 < p < 0.05 ** 0.001 < p < 0.01 *** p < 0.001

Table 3: Summary of self-reported symptoms/diseases among GWV by GWS status (ordered by frequency of reported ill health categories among GWS)

Self-reported symptom	Frequency (%)			Adjusted[2] odds ratio (95% CI)	
	GWS[1] (n = 1,296)	unsure-GWS[1] (n = 9,443)	non-GWS[1] (n= 12,364)	GWS vs non-GWS	unsure GWS vs. non-GWS
All reporting ≥ 1 new symptom / disease since 1990	**1,260 (97.2)**	**7,929 (84.0)**	**4,830 (39.1)**	**48.2 (34.5–67.4)*****	**8.0 (7.5–8.6)*****
Mental and behavioural disorders	**775 (59.8)**	**3,076 (32.6)**	**793 (6.4)**	**18.3 (15.9–21.0)*****	**6.6 (6.0–7.1)*****
Memory loss / lack of concentration	295 (22.8)	1,249 (13.2)	274 (2.2)	12.1 (10.0–14.7)***	6.6 (5.7–7.5)***
Mood swings / aggression / irritability	327 (25.2)	1,147 (12.2)	214 (1.7)	16.1 (13.2–19.7)***	6.9 (5.9–8.0)***
Anxiety / stress / sleep disturbance	220 (17.0)	769 (8.1)	213 (1.7)	10.8 (8.7–13.5)***	4.7 (4.1–5.6)***
Depression	245 (18.9)	613 (6.5)	137 (1.1)	16.1 (12.7–20.4)***	5.5 (4.5–6.6)***
PTSD and associated symptoms (mentioned specifically)	91 (7.0)	116 (1.2)	21 (0.2)	34.9 (20.8–58.7)***	6.4 (4.0–10.5)***
Sexual dysfunction / lack of sex drive	42 (3.2)	123 (1.3)	27 (0.2)	13.1 (7.7–22.3)***	6.4 (4.2–9.9)***
Other psychiatric / psychological disorders NOS[3]	93 (7.2)	237 (2.5)	47 (0.4)	14.7 (10.0–21.7)***	5.7 (4.1–7.9)***
Musculo-skeletal & connective tissue disorders	**500 (38.6)**	**2,118 (22.4)**	**1,156 (9.4)**	**5.3 (4.6–6.1)*****	**2.6 (2.4–2.9)*****
Skeletal & other muscular symptoms	441 (34.0)	1,944 (20.6)	1,107 (9.0)	4.5 (3.9–5.2)***	2.5 (2.3–2.7)***
Muscular pain / weakness (mentioned specifically)	122 (9.4)	265 (2.8)	68 (0.6)	16.2 (11.7–22.5)***	5.1 (3.9–6.7)***
Fatigue	**462 (35.7)**	**1,742 (18.5)**	**397 (3.2)**	**15.4 (13.1–18.2)*****	**6.9 (6.1–7.7)*****
General fatigue	405 (31.3)	1,707 (18.1)	389 (3.2)	13.1 (11.1–15.5)***	6.8 (6.1–7.7)***
Chronic fatigue syndrome / ME (mentioned specifically)	57 (4.4)	35 (0.4)	8 (0.1)	65.3 (29.4–145.1)***	6.1 (2.8–13.5)***
Other symptoms NOS[3]	**407 (31.4)**	**1,720 (18.2)**	**908 (7.3)**	**5.4 (4.7–6.3)*****	**2.8 (2.6–3.1)*****
Nervous system disorders	**373 (28.8)**	**1,284 (13.6)**	**415 (3.4)**	**10.0 (8.4–11.8)*****	**4.1 (3.6–4.6)*****
Headaches	266 (20.5)	958 (10.2)	308 (2.5)	8.7 (7.2–10.6)***	3.9 (3.4–4.5)***
Numbness / tingling / dizziness	101 (7.8)	270 (2.9)	82 (0.7)	9.4 (6.8–12.9)***	4.0 (3.1–5.2)***
Epilepsy	12 (0.9)	30 (0.3)	9 (0.1)	13.0 (5.0–34.1)***	3.5 (1.6–7.5)**
Other neurological and neuromuscular problems NOS[3]	61 (4.7)	114 (1.2)	36 (0.3)	14.3 (9.1–22.5)***	4.2 (2.8–6.2)***
Skin allergies	**242 (18.7)**	**994 (10.5)**	**531 (4.3)**	**4.9 (4.1–5.9)*****	**2.5 (2.3–2.8)*****
Digestive, stomach & intestinal disorders	**194 (15.0)**	**813 (8.6)**	**355 (2.9)**	**5.5 (4.5–6.7)*****	**3.2 (2.8–3.7)*****
Respiratory disorders	**194 (15.0)**	**860 (9.1)**	**400 (3.2)**	**5.1 (4.2–6.2)*****	**3.0 (2.6–3.4)*****
Asthma	71 (5.5)	342 (3.6)	188 (1.5)	3.8 (2.8–5.1)***	2.5 (2.1–3.0)***
Respiratory problems NOS[3]	128 (9.9)	540 (5.7)	222 (1.8)	5.6 (4.4–7.2)***	3.2 (2.7–3.8)***
Infection	**164 (12.7)**	**1,102 (11.7)**	**609 (4.9)**	**2.9 (2.4–3.5)*****	**2.6 (2.4–2.9)*****
Chronic / frequent infection	122 (9.4)	842 (8.9)	372 (3.0)	3.5 (2.8–4.4)***	3.3 (2.9–3.7)***
Single episodes of acute infection	55 (4.2)	319 (3.4)	253 (2.1)	2.2 (1.6–3.0)***	1.8 (1.5–2.1)***
Endocrine, nutritional and metabolic disorders	**116 (9.0)**	**366 (3.9)**	**134 (1.1)**	**7.4 (5.6–9.8)*****	**3.4 (2.8–4.2)*****
Hormonal imbalance / problems	14 (1.1)	36 (0.4)	20 (0.2)	7.0 (3.3–14.8)***	2.4 (1.4–4.2)***
Diabetes	8 (0.6)	29 (0.3)	20 (0.2)	3.3 (1.4–7.9)***	2.0 (1.1–3.6)*
Weight gain / loss	95 (7.3)	306 (3.2)	95 (0.8)	8.0 (5.8–10.9)***	3.9 (3.1–4.9)***
Deterioration in general health	**92 (7.1)**	**494 (5.2)**	**256 (2.1)**	**3.2 (2.5–4.2)*****	**2.5 (2.1–2.9)*****
General deterioration of eyesight / hearing	53 (4.1)	310 (3.3)	212 (1.7)	2.2 (1.6–3.0)***	1.9 (1.5–2.2)***
General decline in fitness / health	41 (3.2)	191 (2.0)	45 (0.4)	8.3 (5.1–13.5)***	5.7 (4.1–8.0)***

Table 3: Summary of self-reported symptoms/diseases among GWV by GWS status (ordered by frequency of reported ill health categories among GWS) *(Continued)*

Cardiovascular disorders	**90 (6.9)**	**344 (3.6)**	**237 (1.9)**	**3.8 (2.9–5.0)*****	**2.1 (1.8–2.5)*****
Genito-urinary system disorders	**77 (5.9)**	**238 (2.5)**	**143 (1.2)**	**5.3 (3.9–7.2)*****	**2.3 (1.8–2.8)*****
Genital system & bladder problems[4]	46 (3.6)	150 (1.6)	79 (0.6)	6.1 (4.0–9.2)***	2.7 (2.0–3.6)***
Kidney disease / symptoms	35 (2.7)	101 (1.1)	68 (0.6)	4.4 (2.8–6.9)***	1.9 (1.4–2.6)***
Night sweats / excessive sweating / "fevers"	**77 (5.9)**	**185 (2.0)**	**49 (0.4)**	**13.7 (9.2–20.2)*****	**4.7 (3.4–6.5)*****
Chest pains / tightness (not elsewhere classified)	**56 (4.3)**	**253 (2.7)**	**87 (0.7)**	**5.5 (3.8–7.9)*****	**3.3 (2.6–4.3)*****
Auto-immune disease	**37 (2.9)**	**136 (1.4)**	**64 (0.5)**	**5.2 (3.3–8.1)*****	**2.8 (2.1–3.8)*****
Allergies other than skin	**31 (2.4)**	**197 (2.1)**	**136 (1.1)**	**2.7 (1.8–4.1)*****	**2.2 (1.7–2.8)*****
Cancer[5]	**19 (1.5)**	**61 (0.7)**	**42 (0.3)**	**5.1 (2.8–9.2)*****	**2.3 (1.5–3.4)*****
Accidental injury	**14 (1.1)**	**128 (1.4)**	**146 (1.2)**	**0.9 (0.5–1.5)**	**1.1 (0.8–1.4)**

[1]Subject can appear in the table as many times as they reported different symptoms. More than one symptom within a group in the same subject counted once only. Number of symptoms in sub-groups may not add up to group total if more than one symptom was recorded within the group for the same subject. [2]Adjusted for age at survey, service and rank at time of Gulf war, serving status at time of survey, alcohol consumption and smoking. [3]Not Otherwise Specified (NOS) [4]Category includes those reporting 'burning semen' GWS 6 (0.5%); unsure-GWS 5 (0.1%); non-GWS 2 (0.0%) [5]Includes all reported malignant neoplasms, plus all reported brain tumours, benign or malignant. * $0.01 < p < 0.05$ ** $0.001 < p < 0.01$ *** $p < 0.001$

swings, memory loss/lack of concentration and headaches. In common with results from other studies of GWV [13,14,19,21], those who stated that they had Gulf War syndrome reported the same types of symptoms as all GWV, but reported them at higher frequencies, providing evidence against a unique syndrome.

Study limitations

In the absence of an official register or a mandatory health evaluation programme, obtaining accurate information from post-combat veterans is a difficult process and one which inevitably relies on self-reporting. This method of data collection introduces possible selection bias into a study. After adjusting for undelivered mail, response rates among men were 53% for GWV and 42% for NGWV [15]. Given the relatively low response rate, an intensive tracing study of non-responders was conducted to investigate possible selection bias. Data from the study indicated that the majority of reasons given for previous non-participation were entirely unrelated to reproduction or Gulf War service. Ninety percent of the reasons given by both GWV and NGWV for earlier non-response related to such things as not remembering receiving a questionnaire, thinking they had sent it back, or general 'mistrust' of the MoD [15]. It might therefore be concluded that response bias relating to adverse health outcomes was not large in this study.

In terms of suitable controls, an advantage of this study was the comparison of GWV with another military cohort. Comparisons with civilian populations may have been misleading as military recruitment involves medical and fitness screening. Furthermore, '*healthy warrior*' *bias* (where veterans deployed to the Gulf might be healthier than those who were not deployed) [22-24] is unlikely to account for the findings in our study because the comparison group were broadly matched to the GWV on fitness to be deployed.

A potential problem with any retrospective study design is recall bias. The questionnaire asked veterans to consider any new medical problems or changes in general health they had experienced since the end of the Gulf War, and this involved them recalling events that might have happened up to seven or eight years in the past. During this time there has been much media speculation over Gulf War illness and this may have introduced recall bias and led to under- or over-reporting of certain symptoms. Gray *et al* have shown that participation in Gulf War health registries is greatly influenced by media attention and is likely to be influenced by compensation issues. This was illustrated by increased enrollment during periods of high media interest in Gulf War issues [17]. A further limitation of this study concerns the lack of clinical validation of self-reported ill health. However, conducting clinical exami-

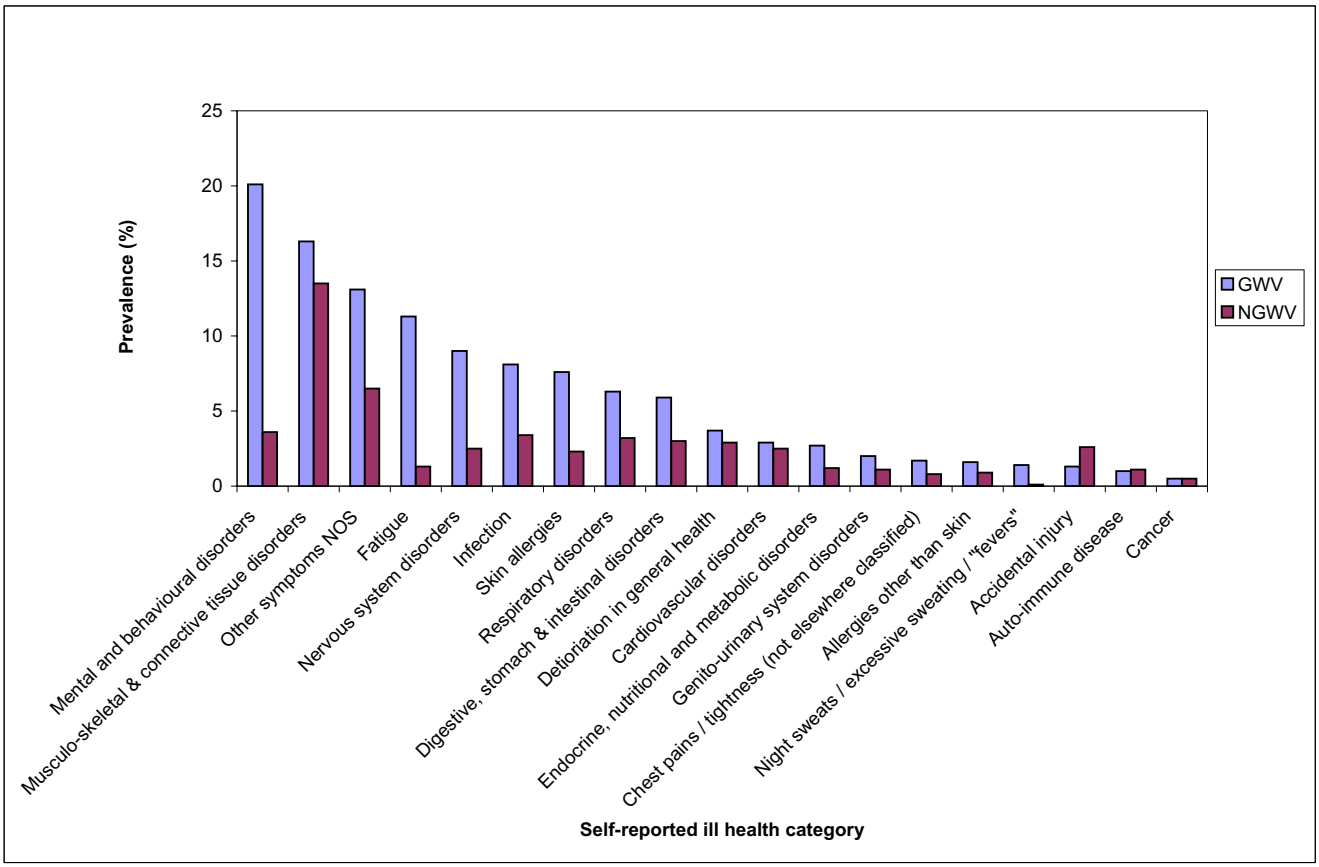

Figure 1
Prevalence of self-reported ill health categories by deployment to the Gulf war (ordered by frequency of reported ill health categories among GWV)

nations and psychiatric assessments of every veteran would have been time consuming and prohibitively expensive. Furthermore, studies looking at 'hard' clinical diagnoses or more objective outcomes, such as cancer [25] or hospitalisation rates [26], have shown no important differences between GWV and comparison groups. Researchers have concentrated instead on differences in 'softer' endpoints [1-3], which are similar to those reported here.

Conclusions

This study is consistent with other research showing a significant excess of morbidity among GWV. It also confirms the lack of specificity in post-Gulf war illness. These findings were replicated despite the fact that reproduction and child health were the focus of the study (rather than the veterans' general health), and questions relating to the veterans' own health were open-ended. Research groups have linked post-Gulf War ill health to a number of self-reported exposures but these analyses are limited by a lack of independent individual-level exposure data [1,27,28]. It has been suggested that changes in perception resulting from the disruption of war rather than specific exposures might be responsible [3], and there have been calls to move away from this narrow focus [29]. In the Gulf, disruption included change of climate, living conditions, diet, sleeping patterns, physical activity and separation from family, as well as the threat of chemical and biological weapons [27]. Despite such conjecture, explaining the increased ill health of GWV remains a controversial subject and there is no real consensus of opinion. In order for more rigorous aetiological studies of post-conflict illness to be undertaken in the future, there is a need to improve routine health surveillance and record-keeping both pre- and post- deployment [30]. This surveillance should also translate into more effective prevention and treatment programs in order to reduce the burden of post-war illness. Further research on the mechanisms underlying the

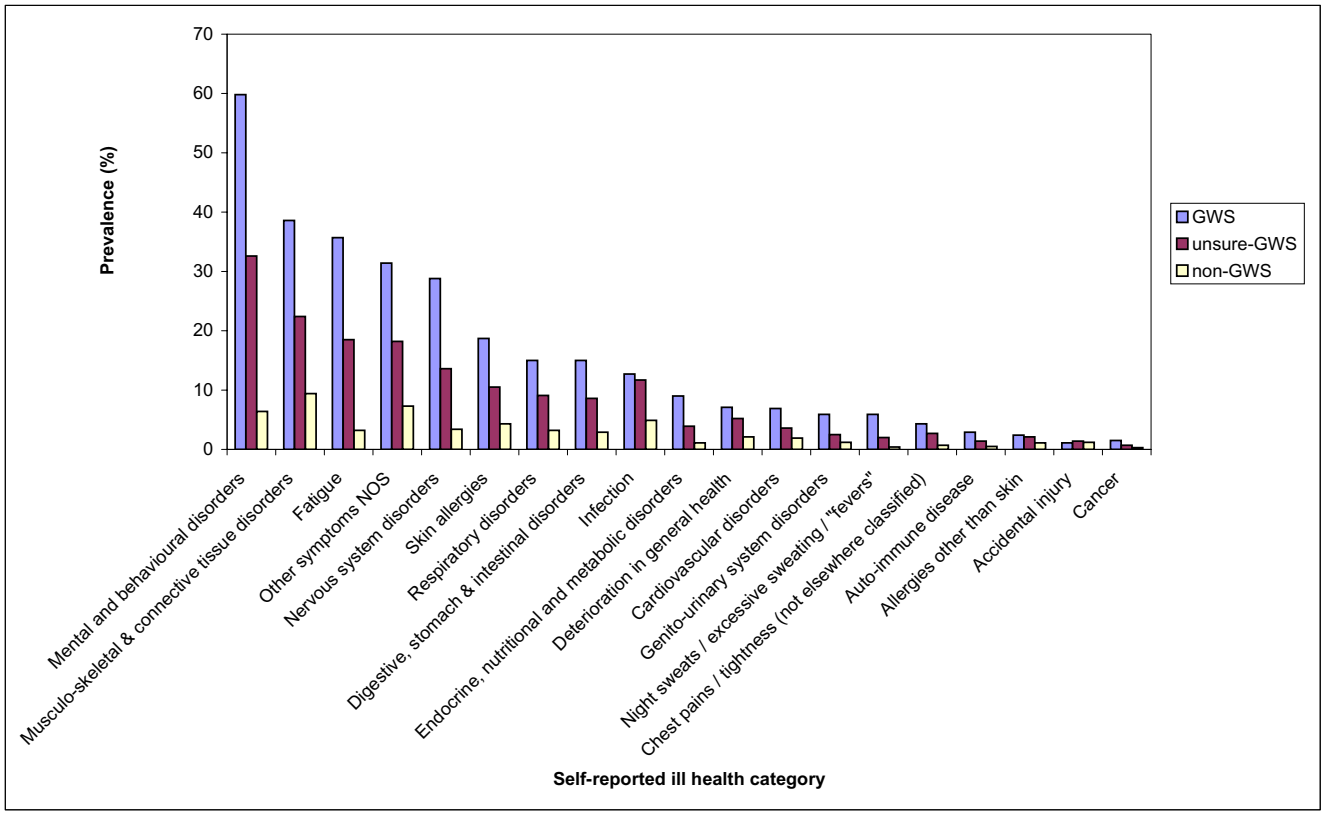

Figure 2
Prevalence of self-reported ill health categories among GWV by GWS status (ordered by frequency of reported ill health categories among GWS)

reporting of ill health is required and this will entail a more qualitative approach to the problem of Gulf War illness. Continued quantitative documentation of the long-term health outcomes of Gulf War veterans remains essential.

List of abbreviations used

GWS Gulf War syndrome

GWV Gulf War veterans

MoD Ministry of Defense (UK)

NGWS non-Gulf War syndrome

NGWV non-Gulf War veterans (comparison group)

RAF Royal Air Force

RN Royal Navy

Competing interests

None declared.

Authors' contributions

RS performed the statistical analysis and drafted the manuscript. NM and PD designed the study and contributed to the writing of the manuscript. All authors read and approved the final manuscript.

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