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ORIGINAL PAPER

Irritable bowel syndrome in the UK military after deployment to Iraq: what are the risk factors?

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Abstract
Purpose Diarrhoea and vomiting (D & V) was common in military personnel during deployment to the initial phases of the Iraq war. D & V is an established risk factor for irritable bowel syndrome (IBS). This study examined the prevalence of IBS in a military sample with a history of deployment to Iraq and the association between D & V and common mental disorder (CMD) with IBS.
Methods The study used data from a two-phase cohort study of military/personnel. The sample was restricted to individuals who had been deployed to Iraq before phase 1 of the study and who had completed the self-report D & V question. A measure of probable IBS was derived at both phases of the study based on self-reported symptoms in the previous month. CMD was assessed by the General Health Questionnaire (GHQ-12).
Results Fifty-nine percent of the sample reported a D & V event and 6.6 % met the criteria for probable IBS at phase 1. Reporting D & V, thinking one might be killed on deployment, poor physical health and CMD were associated with probable IBS at phase 1. CMD at phase 1 was strongly associated with chronic symptoms of IBS.
Conclusions There was a high prevalence of D & V during deployment to the early stages of the Iraq war, yet the prevalence of probable IBS on return from deployment was relatively low. D & V was strongly associated with IBS after deployment, and CMD was a risk factor for chronic symptoms of IBS.

Keywords Irritable bowel syndrome · Common mental disorder · Diarrhoea and vomiting · Gastroenteritis · Military · Deployment

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Introduction

Irritable bowel syndrome (IBS) is a common functional gastrointestinal disorder with a prevalence ranging from 10 to 15 % [1, 2]. The aetiology and diagnosis of IBS is multifactorial [3], with evidence for the roles of early life events or adversity [4], psychiatric disorder including PTSD [5, 6], gastrointestinal (GI) infection [7] and visceral hypersensitivity [8]. Postinfectious IBS (PI-IBS) is a subtype of this syndrome; defined as onset of new IBS symptoms, in an individual who has not previously met the criteria for IBS, immediately following an acute GI illness [9]. The odds of developing IBS increased sevenfold after a GI infection in a meta-analysis of PI-IBS [7]. Individuals who are younger, who are more anxious and depressed [10], female [11] and who have a longer duration of the infectious illness [12] have been identified as being at increased risk.

During recent operations, GI infection was a common cause of hospitalisation of military personnel during deployment, facilitated by poor living conditions and hygiene [13]. The UK Armed Forces experienced a serious outbreak of gastroenteritis during the 2003 invasion of Iraq

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[13]: within the first month, 65 % of the 2,065 military personnel assessed at a military field hospital were diagnosed with gastroenteritis and 73 % of these cases required admission to medical care facilities [13].

Psychological distress and GI infections are relatively common in military personnel [13, 14], suggesting that there could be an increased risk of IBS for the military. However, there are few epidemiological studies examining IBS in military personnel [15, 16] and the prevalence of IBS in UK personnel with a history of deployment to Iraq is unknown. The current study uses data from a two-phase cohort study of the UK military to: (1) report the frequency of both self reported and medically diagnosed diarrhoea and vomiting (D & V) among a representative sample of military personnel who had been deployed to the initial phases of the Iraq war; (2) to determine the prevalence of probable IBS and PI-IBS at phase 1 of the cohort study and the prevalence of chronic IBS (individuals with probable IBS at both phases 1 and 2) in this military sample; (3) to examine the associations between probable IBS/PI-IBS at phase 1 and D & V, childhood adversity, military characteristics, stressful events on deployment and self-reported physical and psychological health reported at phase 1; (4) to determine the association between chronic symptoms of IBS with D & V and physical and psychological health reported at phase 1.

Methods

Study design and participants

Cohort study: phase 1

Data collection for the first phase of this cohort study took place from 2004 to 2006 [14, 17]. The first phase of the cohort study recruited approximately 10 % of UK military personnel who had been deployed to the first phase of the Iraq war, which is known as Operation (Op) TELIC, the UK codename for the deployment in Iraq, and a further sample of the military who had not been deployed to Iraq at that time. Reservists were oversampled at a ratio 2:1 and in total 10,272 participants responded (8,686 Regulars, 1,586 Reservists; 59 % response rate). Of the 10,272 participants who completed phase 1 of the study, 5,905 had been deployed to Op TELIC before phase 1 data collection was undertaken and 4,601 (77.9 %) of these individuals completed the questions (or had data available from a field hospital) on whether or not they had experienced D & V during deployment on Op TELIC.

Cohort study: phase 2

Data collection for the second phase of this cohort study took place from 2007 to 2009 [14, 17]. 9,395 participants from phase 1 were available for follow-up at phase 2, including 37 participants who were late completers of the phase 1 questionnaire [14]. 6,427 of the 9,395 participants available for follow-up completed the phase 2 data collection (68 % response rate). Response at phase 2 was associated with being older, female, an officer and a regular. There was no evidence that mental health status at phase 1 was associated with response at phase 2 [14]. Out of the 4,601 participants included here, 2,781 also completed the phase 2 data collection (60.4 %).

Ethical approval for both phases of the study was granted by the Ministry of Defence Research Ethics Committee (MODREC) and the King's College Hospital local research ethics committee and all persons gave their informed consent prior to their inclusion in the study.

Operational emergency department attendance register

Operational emergency department attendance register (OpEDAR) is a record of attendances to field hospitals on deployment [18]. OpEDAR data were supplied by the UK Ministry of Defence (MoD) (via Defence Analytical Services and Advice) for participants who completed phase 1 data collection ($N = 5{,}905$) and provided consent for us to access their medical records. Data were provided on date and location of attendance, diagnosis, disease or injury classification (e.g., psychiatric, musculoskeletal, respiratory) and management plan (returned to unit, admitted to hospital, or medically evacuated by air to the UK). D & V events were recorded on OpEDAR by emergency department staff and were identified from the diagnosis and disease or injury classification fields [19]. These data were linked to the main cohort.

Measures

Diarrhoea and vomiting

At phase 1 of the cohort study, participants reported whether they had experienced 'diarrhoea and/or vomiting during deployment on Op TELIC 1'. This self-report data was enhanced by routinely collected data of hospital attendances in Iraq from OpEDAR: specifically all OpEDAR D & V events that occurred before completion of the phase 1 questionnaire for the cohort study. The self-report and OpEDAR D & V measures were combined and this variable was ordered according to severity as no D & V event, self reported D & V and then D & V recorded on

OpEDAR. If an OpEDAR event was recorded then this was counted, regardless of self-report status.

In total, 4,561 participants completed the self-report D & V question at phase 1. 180/4,561 with self-report data also had a D & V event that was recorded on OpEDAR prior to completing phase 1. However, there were 220 OpEDAR D & V events in total, including 40/220 participants who had not completed the D & V self-report item and 8/220 participants who reported that they had not had D & V on Op Telic 1.

Irritable bowel syndrome

Symptoms of IBS were assessed at both phases of the cohort study through self-reported items referring to symptoms experienced in the 'past month'. A proxy measure of probable IBS was derived based on the Rome III criteria [20] and the presence of the following self-reported symptoms were used to identify participants probable IBS: (a) presence of stomach cramps or stomach bloating, changeable bowel function and constipation; (b) presence of stomach cramps or stomach bloating, changeable bowel function and diarrhoea; and (c) presence of stomach cramps or stomach bloating, constipation and diarrhoea. A measure of chronic symptoms of IBS was derived, which included participants with probable IBS at phases 1 and 2.

Childhood adversity

At phase 1, childhood adversity was assessed by 16 items [21], adapted from the Adverse Childhood Exposure study scale [22]. Two measures were subsequently generated. The first assessed family relationship adversity: comprising four positive items, which were reverse scored (e.g. "I came from a close family") and four negative items (e.g. "I used to be hit/hurt by a parent or caregiver regularly") [21], summed and analysed as 0, 1 and 2+ adversities. The second measure assessed childhood antisocial behaviour, scored positively if participants answered true to "I used to get into physical fights at school" plus one of the following; "I often used to play truant at school" or "I was suspended or expelled from school" or "I did things that should have got me (or did get me) into trouble with the police" [23].

Psychological measures

At phases 1 and 2, symptoms of PTSD were assessed by the National Centre for PTSD Checklist—Civilian version (PCL-C 24); a 17-item questionnaire assessing five re-experiencing, seven avoidance and five hyperarousal symptoms. Cases were defined as individuals with a score of 50 or above [24]. Symptoms of anxiety and depression [otherwise known as common mental disorder (CMD)] were measured by the General Health Questionnaire 12 (GHQ-12; [25]), with cases defined as individuals with a score of four or above (range of scores 0–12). General health status was assessed using one item from the SF-36 [26], with individuals rating their health as 'poor' or 'fair', compared to individuals rating their health as 'good', 'very good' or 'excellent'. Alcohol use was measured by the 10-item World Health Organization's (WHO) Alcohol Use Disorders Identification Test (AUDIT; [27]). A score of 16 or more, out of a possible range of scores from 0 to 40, was used to define alcohol misuse (hazardous use, likely to be harmful to health) [14].

Data analysis

Analyses were conducted in STATA 11.0 [28]. All the analyses presented here used the survey command and weighted means, percentages, relative risk ratios and odds ratios are presented with unweighted cell counts. All analyses adjusted for the demographic confounders (sex, age, marital status and educational attainment) that were statistically significantly associated with the D & V and IBS outcomes ($p < 0.05$).

1. The weighted prevalence of self-reported D & V and D & V events on OpEDAR were calculated. Multinomial regressions were conducted to calculate multinomial odds ratios for the associations between self-reported D & V and D & V events reported on OpEDAR, with socio-demographic and military characteristics at phase 1, using the no D & V group as the baseline group.
2. The weighted prevalence of probable IBS and PI-IBS at phase 1 and chronic symptoms of IBS across phases 1 and 2 were calculated.
3. Logistic regression analyses were conducted to calculate ORs (and 95 % confidence intervals) for the association between probable IBS/PI-IBS at phase 1 with military characteristics, smoking status and physical and psychological health reported at phase 1 after adjustment for sex and age. Multivariable logistic regression models were generated, which included any variables which were still significantly associated ($p < 0.05$) with probable IBS or PI-IBS at phase 1 after the initial adjustment.
4. Logistic regression analyses were conducted to calculate ORs for the association between chronic symptoms of IBS at phases 1 and 2 and D & V, smoking status, physical and psychological health at phase 1 and change in psychological health status from phases 1 to 2, first using the no IBS group as the reference

category (adjusted initially for sex and D & V and then for sex, D & V and CMD) and second using the recovered IBS group as the reference category (no adjustments made due to small numbers).

For the phase 1 analyses, sample weights were created to account for the oversampling of reservists at phase 1 and the phase 2 follow-up analyses used a weight which multiplied the phase 1 sampling weight with the probability of response (inverse probability of responding once sampled, by factors that predicted response: sex, rank, engagement type, age, sample) at time 2 [14].

Results

Prevalence of D & V and IBS

Two thousand seven hundred and twenty-three participants (59.1 %, 95 % CI 57.6–60.5 %) had a self-report D & V event only, and 220 (4.3 %, 95 % CI 3.7, 4.9 %) had an OpEDAR D & V event recorded. 6.6 % of the sample (95 % CI 5.9–7.3 %; males 5.9 %, females 14.3 %; $n = 316$) met the criteria for probable IBS at phase 1. The prevalence of probable PI-IBS in personnel with a self report (or OpEDAR) D & V event was somewhat higher (8.8 %, 95 % CI 7.7–9.8 %); and was considerably higher when restricted to those with an OpEDAR D & V event (15.3 %, 95 % CI 10.2–20.3 %).

Two thousand four hundred and seventy-two participants did not report probable IBS at either phase 1 or 2 (89.1 %, 95 % CI 87.9–90.3 %); 52 met the criteria at phases 1 and 2 (chronic symptoms of IBS) (1.7 %, 95 % CI 1.2–2.2 %), 142 had probable IBS at phase 1 but not at phase 2 (recovered IBS) (4.9 %, 95 % CI 4.1–5.8 %) and there were 115 new cases of probable IBS at phase 2 (4.2 %, 95 % CI 3.4–5.0 %).

Associations between military and deployment experiences with self-reported D & V and D & V events recorded on OpEDAR

Table 1 shows that after adjustment for sex, age, marital status and educational attainment, military personnel who were older, more educated, from the RAF and Naval services, regulars and non-smokers were less likely to self-report D & V on a TELIC deployment or have a D & V event recorded on OpEDAR. Those holding a non-officer rank or who were in a combat role were more likely to self-report D & V, but were no more likely to have an OpEDAR event. Females were more likely to have had a D & V event recorded on OpEDAR.

Associations with probable IBS at phase 1

Being female (OR = 2.64, 95 % CI 1.93, 3.62) was associated with increased odds and aged under 25 years (compared to 25–34 years) (OR = 0.62, 95 % CI 0.43, 0.89) was associated with reduced odds of probable IBS (not reported in the table). Marital status and educational attainment were not associated with probable IBS (results not shown but available from the authors). Table 2 shows that in the multivariable model, self-reporting D & V and an OpEDAR record of D & V on deployment; thinking that one might be killed on deployment; self-reporting fair/poor general health and CMD were associated with probable IBS at phase 1.

For individuals who did not report D & V on deployment to Op TELIC, associations with IBS at phase 1 included being female, reporting poor general health and CMD (results not shown but available from the authors).

Associations with probable postinfectious-IBS at phase 1

For those who had D & V on deployment to Iraq, being female (OR = 2.15, 95 % CI 1.48, 3.12) and younger age (aged under 25 years; OR = 0.52, 95 % CI 0.35, 0.78) were associated with probable PI-IBS (not reported in the table). Table 3 shows that in the multivariable model, significant associations were found for thinking one might be killed, self-reported fair/poor health and CMD.

Associations with chronic symptoms of IBS

Female gender (OR = 3.60, 95 % CI 1.85, 7.00) was associated with chronic symptoms of IBS, but age, marital status and educational attainment were not (results not shown but available from the authors). Table 4 shows that after adjustments were made, CMD at phase 1 was strongly associated with chronic symptoms of IBS. D & V, self-reporting fair/poor health and PTSD were also associated with medium effect sizes ranging from OR 2 to 4. There was weaker evidence for an association between smoking and chronic symptoms of IBS. In regard to change in psychological health status, individuals who reported CMD at both phases 1 and 2 were more likely to also report chronic symptoms of IBS, in addition to those who reported CMD at phase 1 only. Compared to the recovered IBS group, individuals with chronic symptoms of IBS were more likely to report CMD at phase 1.

Discussion

Diarrhoea and vomiting was common in UK military personnel during the first phase of the Iraq war, reported by

Table 1 Associations between phase 1 socio-demographic and military characteristics and D & V on TELIC deployment ($N = 4,601$)

	No D & V ($N = 1,658^{\pm}$) *n* (weighted %)	Self-reported D & V ($N = 2,723^{\pm}$) *n* (weighted %)	D & V event on OpEDAR ($N = 220^{\pm}$) *n* (weighted %)	Self reported D & V Adjusted for confounders[1] MOR (95 % CI)	D & V event on OpEDAR Adjusted for confounders[1] MOR (95 % CI)
Sex					
Male	1,503 (91.3)	2,503 (92.6)	175 (81.9)	1.00	1.00
Female	155 (8.7)	220 (7.4)	45 (18.1)	0.79 (0.62, 1.00)	2.06 (1.36, 3.12)***
Age at phase 1 (years)					
<25	260 (16.7)	553 (21.9)	42 (22.5)	1.10 (0.91, 1.32)	1.06 (0.70, 1.60)
25–34	672 (41.6)	1,222 (46.2)	96 (47.2)	1.00	1.00
35–44	556 (32.7)	795 (27.5)	59 (23.1)	0.73 (0.63, 0.85)***	0.61 (0.42, 0.90)*
45+	170 (9.0)	153 (4.4)	23 (7.2)	0.42 (0.33, 0.55)***	0.72 (0.42, 1.24)
Marital status					
In a relationship	1,300 (78.6)	2,008 (74.2)	160 (73.3)	1.00	1.00
Single, divorced, separated, widowed	354 (21.4)	702 (25.8)	59 (26.7)	1.15 (0.98, 1.35)	1.25 (0.88, 1.76)
Educational attainment					
Low (O Levels or none)	694 (45.4)	1,276 (50.7)	104 (54.0)	1.00	1.00
High (A Levels, degree and above)	866 (54.6)	1,295 (49.3)	99 (46.0)	0.88 (0.77, 1.00)	0.73 (0.53, 0.99)*
Service[†]					
Naval services	396 (24.5)	299 (11.2)	2 (0.8)	0.28 (0.23, 0.34)***	–
Army	772 (45.6)	2,065 (75.2)	214 (96.9)	1.00	–
Royal air force	490 (29.9)	359 (13.6)	4 (2.2)	0.29 (0.25, 0.35)***	–
Rank					
Other rank	1,314 (79.7)	2,335 (86.5)	178 (84.2)	1.00	1.00
Officer	343 (20.3)	376 (13.5)	42 (15.8)	0.74 (0.61, 0.90)***	0.79 (0.50, 1.26)
Engagement type					
Regular	1,428 (92.6)	2,249 (90.5)	140 (77.8)	1.00	1.00
Reservist	230 (7.4)	474 (9.5)	80 (22.2)	1.78 (1.46, 2.18)***	4.63 (3.22, 6.66)***
Role in theatre					
Non-combat	1,331 (80.0)	1,894 (68.2)	182 (81.7)	1.00	1.00
Combat	318 (20.0)	823 (31.8)	35 (18.3)	1.69 (1.44, 1.98)***	0.89 (0.59, 1.33)
Smoking status					
Non-smoker	896 (53.8)	1,271 (45.9)	110 (46.9)	1.00	1.00
Ex-smoker	337 (20.5)	591 (22.0)	36 (16.4)	1.30 (1.10, 1.53)***	0.93 (0.61, 1.44)
Current smoker	425 (25.8)	860 (32.1)	74 (36.7)	1.38 (1.19, 1.62)***	1.59 (1.12, 2.26)**

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.005$

[±] Cell sizes differ due to missing data, *MOR* multinomial odds ratio

[†] Analyses are not reported for the OpEDAR group due to low numbers

[1] Model adjusted for sex, age, marital status and educational attainment

Table 2 Associations with probable IBS at phase 1 ($N = 4,601$)

	No IBS ($N = 4,285^{\pm}$) *n* (weighted %)	IBS ($N = 316^{\pm}$) *n* (weighted %)	Adjusted for confounders[1] OR (95 % CI) ($N = 4,601$)	Multivariable model[2] OR (95 % CI) ($N = 4,361$)
Service				
Naval services	658 (15.8)	39 (13.1)	0.77 (0.54, 1.11)	–
Army	2,882 (64.9)	229 (70.4)	1.00	–
Royal Air Force	805 (19.3)	48 (16.5)	0.74 (0.53, 1.03)	–
Rank				
Other rank	3,561 (83.8)	266 (85.3)	1.00	–
Officer	715 (16.2)	46 (14.8)	0.73 (0.51, 1.04)	–
Engagement type				
Regular	3,576 (91.0)	241 (86.5)	1.00	–
Reservist	709 (9.0)	75 (13.5)	1.35 (1.00, 1.83)	–
Role in theatre				
Non-combat	3,179 (73.2)	228 (70.9)	1.00	1.00
Combat	1,088 (26.8)	88 (29.1)	1.35 (1.03, 1.78)*	1.19 (0.84, 1.69)
Discharged weapon in direct combat				
No	3,544 (82.9)	251 (79.7)	1.00	1.00
Yes	693 (17.1)	61 (20.3)	1.49 (1.09, 2.03)*	0.96 (0.65, 1.42)
Thought might be killed				
No	1,787 (42.8)	74 (24.4)	1.00	1.00
Yes	2,444 (57.2)	242 (75.6)	2.37 (1.80, 3.11)***	1.50 (1.10, 2.04)*
Problems at home during deployment				
No	3,431 (80.9)	215 (70.9)	1.00	1.00
Yes	852 (19.1)	101 (29.1)	1.75 (1.35, 2.26)***	1.04 (0.77, 1.42)
D & V				
No report	1,608 (38.1)	50 (16.2)	1.00	1.00
Self-reported D & V	2,489 (58.0)	234 (74.0)	3.17 (2.30, 4.35)***	2.59 (1.83, 3.67)***
D & V event on OpEDAR	188 (3.9)	32 (9.9)	5.62 (3.41, 9.26)***	4.34 (2.55, 7.39)***
Smoking status				
Non-smoker	2,146 (49.5)	131 (39.3)	1.00	1.00
Ex-smoker	898 (21.1)	66 (22.6)	1.35 (0.99, 1.85)	1.32 (0.94, 1.85)
Current smoker	1,240 (29.4)	119 (38.1)	1.68 (1.29, 2.20)***	1.30 (0.95, 1.76)
Alcohol misuse (Case on AUDIT 16+)				
Non-case	3,539 (83.1)	236 (74.0)	1.00	1.00
Case	688 (16.9)	78 (26.0)	2.03 (1.51, 2.72)***	1.25 (0.90, 1.75)
Childhood adversity–family relationship				
0 adversities	1,838 (44.5)	117 (39.0)	1.00	1.00
1 adversity	830 (20.1)	51 (16.6)	1.02 (0.72, 1.44)	0.87 (0.59, 1.27)
2 or more adversities	1,464 (35.4)	139 (44.4)	1.52 (1.16, 1.98)***	1.09 (0.81, 1.46)
Childhood adversity–antisocial behaviour				
No	3,426 (80.5)	234 (74.1)	1.00	1.00
Yes	790 (19.5)	78 (25.9)	1.71 (1.29, 2.27)***	0.99 (0.72, 1.38)
General health status				
Excellent/good	3,831 (90.3)	209 (66.9)	1.00	1.00
Fair/poor	429 (9.7)	104 (33.1)	4.56 (3.49, 5.96)***	2.61 (1.90, 3.59)***
PTSD				
Non-case	4,064 (96.4)	269 (86.8)	1.00	1.00

Table 2 continued

	No IBS ($N = 4,285^{\pm}$) *n* (weighted %)	IBS ($N = 316^{\pm}$) *n* (weighted %)	Adjusted for confounders[1] OR (95 % CI) ($N = 4,601$)	Multivariable model[2] OR (95 % CI) ($N = 4,361$)
Case	157 (3.6)	44 (13.2)	4.35 (2.98, 6.36)***	1.50 (0.96, 2.35)
Common mental disorder (GHQ-12)				
Non-case	3,447 (81.8)	161 (51.4)	1.00	1.00
Case	791 (18.2)	153 (48.6)	4.21 (3.30, 5.37)***	2.60 (1.91, 3.52)***

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.005$

$^{\pm}$ Cell sizes differ due to missing data

[1] Model adjusted for sex and age, [2] Multivariable model included any variables associated with IBS after adjustment for sex and age

over half of the large random sample of personnel included in this study. Whilst the overall prevalence of probable IBS in our military sample was lower than estimates for the general population of the UK [1, 2], the prevalence of probable PI-IBS in personnel who had reported D & V was comparable with the findings of a meta-analysis of PI-IBS [7]. Associations with probable PI-IBS included being female, being younger in age, thinking one might be killed on deployment, reporting poor general health and CMD. Personnel who had a D & V event recorded on OpEDAR were the most likely to report probable IBS at phase 1, with additional risk factors comparable to those for PI-IBS. The strongest associations with chronic symptoms of IBS were D & V, reporting poor health, PTSD and CMD.

Most of the individuals with a recorded event of D & V from a field hospital also had a self-report event. Whilst age and smoking status were associated with both self-report and OpEDAR D & V events, OpEDAR events were more likely be recorded in females and reservists and self-report events were more common in those in a combat role. These effects may be due to access to the field hospitals; personnel in combat would more likely have been treated within their unit away from a base hospital, whilst those in particular roles such as medics (who are more likely to be female and reservists, particularly during the early phases of Op TELIC) would have been more able to access services at a field hospital and would also be required to report symptoms of an infection. Having an OpEDAR D & V event was most strongly associated with probable IBS at phase 1, suggesting that this could indicate a severe case of GI illness that was more likely to result in symptoms of IBS on return from deployment.

The current findings using a military sample corroborate existing literature of PI-IBS regarding an association with being female [11] and the cognitive-behavioural model of IBS, which suggests that individuals with higher levels of anxiety or depression are more likely to report IBS after a GI infection [10, 29]. There was further evidence that thinking one might be killed was associated with probable PI-IBS, in support of an association between stress and probable PI-IBS [29, 30]. However, whilst most research has shown that younger individuals are more likely to develop PI-IBS [10], this study found that personnel under 25 years of age were actually less likely to meet the criteria for probable PI-IBS after D & V compared to those aged 25–34 years.

The link between IBS and psychopathology is well established [31] and CMD and PTSD were strongly associated with the likelihood that an individual experienced chronic symptoms of IBS. The association between psychopathology and IBS may be bidirectional; however, a number of studies have shown that psychopathology precedes IBS, with evidence for higher levels of IBS symptoms in patients with panic disorder [32], general anxiety disorder and major depressive disorder [33]. This association seems to be greater for anxiety disorders including panic disorder [34], and PTSD [6], which may have a similar pathophysiology to IBS [32, 35]. Anxiety-related constructs such as hypervigilance to internal symptoms and intolerance to sensations of discomfort are related to IBS [36] and may result in the exacerbation and maintenance of IBS symptoms. Thinking one might be killed on deployment was also associated with probable IBS [37, 38], which could be a marker of both heightened perceptions of danger and general levels of anxiety during deployment.

Strengths and weaknesses

Strengths of this study included a large military sample and prospective data on symptoms of IBS in the same individuals across an average 3-year time span, which allowed us to assess the longer term impact of D & V in addition to change in IBS status over time. This study also benefits from two measures of D & V events on deployment to Iraq and is the first of which we are aware to assess the association between D & V during the Iraq war and IBS in a UK military sample. The weaknesses of this study included the proxy measure of IBS: the Rome criteria refers to symptoms that are present for 3 months, and in this study symptoms were reported for the previous month and may

Table 3 Associations with probable postinfectious-IBS at phase 1 restricted to personnel with a report of D & V ($N = 2,943$)

	No IBS ($N = 2,677^{\pm}$) *n* (weighted %)	IBS ($N = 266^{\pm}$) *n* (weighted %)	Adjusted for confounders[1] OR (95 % CI) ($N = 2,943$)	Multivariable model[2] OR (95 % CI) ($N = 2,813$)
Service				
Naval services	273 (10.4)	28 (11.3)	1.19 (0.78, 1.82)	–
Army	2,078 (77.0)	201 (73.7)	1.00	–
Royal Air Force	326 (12.6)	37 (15.0)	1.15 (0.79, 1.68)	–
Rank				
Other rank	2,289 (86.5)	224 (85.4)	1.00	–
Officer	380(13.5)	38 (14.6)	0.88 (0.59, 1.30)	–
Engagement type				
Regular	2,188 (90.0)	201 (86.1)	1.00	–
Reservist	489 (10.0)	65 (13.9)	1.22 (0.87, 1.71)	–
Role in theatre				
Non-combat	1,889 (69.1)	187 (68.7)	1.00	–
Combat	779 (30.9)	79 (31.3)	1.20 (0.90, 1.62)	–
Discharged weapon in direct combat				
No	2,126 (79.3)	207 (77.8)	1.00	
Yes	519 (20.7)	56 (22.2)	1.27 (0.91, 1.78)	
Thought might be killed				
No	883 (33.8)	56 (21.6)	1.00	1.00
Yes	1,759 (66.2)	210 (78.4)	1.90 (1.38, 2.61)***	1.42 (1.02, 2.00)*
Problems at home during deployment				
No	2,101 (79.5)	177 (69.6)	1.00	1.00
Yes	574 (20.5)	89 (30.4)	1.70 (1.28, 2.26)***	1.06 (0.76, 1.48)
Smoking status				
Non-smoker	1,270 (46.6)	111 (39.4)	1.00	1.00
Ex-smoker	573 (21.6)	54 (22.1)	1.21 (0.85, 1.72)	1.18 (0.82, 1.72)
Current smoker	833 (31.8)	101 (38.5)	1.50 (1.12, 2.02)**	1.22 (0.87, 1.70)
Alcohol misuse (Case on AUDIT 16+)				
Non-case	2,153 (80.8)	194 (72.0)	1.00	1.00
Case	485 (19.2)	70 (28.0)	1.97 (1.43, 2.70)***	1.40 (0.98, 2.00)
Childhood adversity–family relationship				
0 adversities	1,092 (42.4)	100 (39.2)	1.00	1.00
1 adversity	544 (21.0)	44 (16.9)	0.91 (0.62, 1.34)	0.84 (0.56, 1.27)
2 or more adversities	936 (36.6)	116 (44.0)	1.35 (1.01, 1.81)*	1.05 (0.76, 1.44)
Childhood adversity–antisocial behaviour				
No	2,053 (77.0)	194 (72.7)	1.00	1.00
Yes	576 (23.0)	69 (27.3)	1.48 (1.09, 2.00)*	1.02 (0.72, 1.43)
General health status				
Excellent/good	2,364 (89.0)	174 (66.5)	1.00	1.00
Fair/poor	300 (11.0)	89 (33.5)	4.05 (3.01, 5.46)***	2.48 (1.76, 3.49)***
PTSD				
Non-case	2,514 (95.6)	225 (85.8)	1.00	1.00
Case	119 (4.4)	39 (14.2)	3.86 (2.56, 5.82)***	1.48 (0.91, 2.39)
Common mental disorder (GHQ-12)				
Non-case	2,097 (80.0)	133 (50.3)	1.00	1.00
Case	543 (20.0)	132 (49.7)	3.93 (3.00, 5.14)***	2.58 (1.86, 3.57)***

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.005$

$^{\pm}$ Cell sizes differ due to missing data

[1] Model adjusted for sex and age, [2] Multivariable model included any variables associated with IBS after adjustment for sex and age

Table 4 Associations with chronic/recovered IBS between phases 1 and 2

	No IBS ($n = 2{,}472^{\pm}$) *n* (weighted %)	Chronic IBS ($n = 52^{\pm}$) *n* (weighted %)	No IBS vs. Chronic IBS adjusted model[1] OR (95 % CI) ($N = 2{,}524$)	No IBS vs. Chronic IBS adjusted model[2]OR (95 % CI) ($N = 2{,}508$)	Recovered ($n = 142$) *n* (weighted %)	Recovered IBS vs. Chronic IBS unadjusted models OR (95 % CI) ($N = 236$)
D & V						
No report	958 (39.0)	10 (18.5)	1.00	1.00	20 (14.5)	1.00
Self-reported/D & V event on OpEDAR[†]	1,514 (61.0)	42 (81.5)	2.83 (1.38, 5.81)**	2.60 (1.25, 5.38)*	122 (85.5)	0.75 (0.31, 1.79)
Smoking status at phase 1						
Non-smoker	1,283 (50.8)	24 (42.1)	1.00	1.00	65 (3.2)	1.00
Ex-smoker	526 (21.3)	6 (12.3)	0.66 (0.26, 1.68)	0.72 (0.28, 1.85)	34 (5.7)	0.49 (0.18, 1.36)
Current smoker	663 (27.9)	22 (45.6)	1.94 (1.05, 3.59)*	1.94 (1.04, 3.61)*	43 (31.1)	1.51 (0.72, 3.13)
Alcohol misuse at phase 1 (Case on AUDIT 16 +)						
Non-case	2,091 (83.6)	38 (70.1)	1.00	1.00	106 (75.3)	1.00
Case	356 (16.4)	14 (29.9)	2.15 (1.12, 4.14)*	1.58 (0.81, 3.06)	34 (24.7)	1.30 (0.60, 2.77)
General health status at phase 1						
Excellent/good	2,217 (90.4)	34 (64.7)	1.00	1.00	103 (73.7)	1.00
Fair/poor	242 (9.6)	18 (35.3)	4.88 (2.62, 9.08)***	2.96 (1.49, 5.86)***	37 (26.3)	1.53 (0.74, 3.14)
PTSD at phase 1						
Non-case	2,381 (96.9)	41 (79.5)	1.00	1.00	126 (89.5)	1.00
Case	72 (3.1)	11 (20.5)	8.34 (3.89, 17.88)***	3.39 (1.47, 7.79)***	15 (10.5)	2.19 (0.88, 5.44)
Common mental disorder (GHQ-12) at phase 1						
Non-case	2,004 (81.9)	22 (41.5)	1.00	1.00	82 (58.9)	1.00
Case	452 (18.1)	30 (58.5)	5.92 (3.28, 10.69)***	5.92 (3.28, 10.69)***	60 (41.1)	2.03 (1.03, 3.98)*
Change in psychological health status between phases 1 and 2						
No CMD	1,747 (72.2)	19 (35.7)	1.00	–	57 (42.3)	1.00
CMD at both phases	180 (7.1)	16 (30.6)	7.94 (3.88, 16.22)***	–	26 (17.7)	2.06 (0.88, 4.83)
Positive change	264 (10.8)	14 (27.9)	4.83 (2.28, 10.24)***	–	33 (23.3)	1.42 (0.60, 3.33)
Negative change	240 (9.9)	3 (5.8)	1.17 (0.33, 4.12)	–	23 (16.7)	0.41 (0.10, 1.61)

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.005$

[1] Model adjusted for sex and D & V at phase 1, [2] Model adjusted for sex, D & V and CMD at phase 1

[±] Cell sizes differ due to missing data

[†] Categories combined due to lower numbers in the OpEDAR D & V group

have been temporary. A further bias of using this measure is that the prevalence of IBS may have been overestimated in comparison to using clinical diagnoses; however, the prevalence in the current study was still lower than in previous studies in the UK population. In addition, there was no way of identifying when the onset of IBS occurred; individuals may already have had IBS before deployment to Iraq, but it is unlikely that personnel would be medically downgraded, and prevented from deploying, as a result of symptoms of IBS. Furthermore, self-reports of D & V are subjective and whilst the objective OpEDAR reports may indicate a greater severity of GI infection, this was limited to a small number of participants.

Clinical implications

Probable IBS was not common in this military sample, but personnel who had experienced D & V on deployment

were more likely to report symptoms of IBS. Clinicians should be aware that personnel who report IBS and who also have CMD may be at risk of chronic symptoms of IBS.

Conclusions

There was a high prevalence of D & V on deployments to the early stages of the Iraq war, yet the prevalence of probable IBS in the military on return from deployment was relatively low. D & V was strongly associated with IBS after deployment. CMD was strongly associated with chronic symptoms of IBS, in addition to D & V, PTSD and poor general health.

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