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Original Contribution

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The effect of military deployments to combat environments on disordered eating and weight changes is unknown. Using longitudinal data from Millennium Cohort Study participants who completed baseline (2001–2003) and follow-up (2004–2006) questionnaires ($n = 48,378$), the authors investigated new-onset disordered eating and weight changes in a large military cohort. Multivariable logistic regression was used to compare these outcomes among those who deployed and reported combat exposures, those who deployed but did not report combat exposures, and those who did not deploy in support of the wars in Iraq and Afghanistan. Deployment was not significantly associated with new-onset disordered eating in women or men, after adjustment for baseline demographic, military, and behavioral characteristics. However, in subgroup comparison analyses of deployers, deployed women reporting combat exposures were 1.78 times more likely to report new-onset disordered eating (95% confidence interval: 1.02, 3.11) and 2.35 times more likely to lose 10% or more of their body weight compared with women who deployed but did not report combat exposures (95% confidence interval: 1.17, 4.70). Despite no significant overall association between deployment and disordered eating and weight changes, deployed women reporting combat exposures represent a subgroup at higher risk for developing eating problems and weight loss.

body weight changes; cohort studies; eating disorders; military medicine; military personnel

Abbreviation: CI, confidence interval.

The prevalence of eating disorders such as bulimia nervosa among women is 1%–3%, with rates in men believed to be one-tenth of those reported among women (1, 2). Studies conducted among military populations have found rates of bulimia nervosa of 8% for women and 7% for men, rates that exceed population estimates (3, 4). The elevated prevalence of eating disorders in military personnel is of concern because of significant associated comorbidities, including substance abuse (2, 5–8), mental health disorders (2, 5, 9), other physical complications (10, 11), and the potential for attempted suicide (12). Changes in eating resulting in weight gain or loss also have been associated with stress (13–15) and have been linked to physical and mental health problems (16, 17). Given the deleterious health consequences of eating disorders and weight changes to military per-

sonnel, it is important to identify factors that may explain increased risk for developing these problems.

Military personnel who deploy to combat regions are commonly exposed to trauma, such as witnessing serious injury or death (18–20). Research regarding past and current conflicts in the Persian Gulf has found that deployment-related stress produces anxiety, depression, post-traumatic stress disorder, and substance abuse among certain individuals (21–25). Therefore, we hypothesized that deployment in support of the wars in Iraq and Afghanistan would predict new-onset disordered eating and extreme weight change. Previous research has identified vulnerable subpopulations whose disordered eating may have been triggered by stressful events (9, 26–28). However, the majority of these studies used retrospective designs, which are vulnerable to recall

Table 1. Baseline Characteristics of Women and Men by New-Onset Disordered Eating Status ($N = 46,219$), the Millennium Cohort Study, 2001–2006

Characteristic	Women					Men				
	Total (<i>n</i> = 12,641)	New-Onset Disordered Eating (<i>n</i> = 415)		No Disordered Eating (<i>n</i> = 12,226)		Total (<i>n</i> = 33,578)	New-Onset Disordered Eating (<i>n</i> = 886)		No Disordered Eating (<i>n</i> = 32,692)	
		No.	% ^a	No.	% ^a		No.	% ^a	No.	% ^a
Deployment status										
Nondeployed	10,686	349	84.1	10,337	84.5	24,830	666	75.2	24,164	73.9
Deployed without combat exposures	1,085	29	7.0	1,056	8.6	4,351	99	11.2	4,252	13.0
Deployed with combat exposures	870	37	8.9	833	6.8	4,397	121	13.7	4,276	13.1
Experienced ≥1 deployments of >9 months										
No	12,261	399	96.1	11,862	97.0	32,037	836	94.4	31,201	95.4
Yes	380	16	3.9	364	3.0	1,541	50	5.6	1,491	4.6
Birth year										
Before 1960	2,813	92	22.2	2,721	22.3	9,037	198*	22.3*	8,839*	27.0*
1960–1969	4,586	129	31.1	4,457	36.5	14,182	364*	41.1*	13,818*	42.3*
1970–1979	4,323	158	38.1	4,165	34.1	9,434	294*	33.2*	9,140*	28.0*
1980 or later	919	36	8.7	883	7.2	925	30*	3.4*	895*	2.7*
Race/ethnicity										
White, non-Hispanic	8,041	284	68.4	7,757	63.4	24,784	668*	75.4*	24,116*	73.8*
Black, non-Hispanic	2,529	70	16.9	2,459	20.1	3,147	61*	6.9*	3,086*	9.4*
Other	2,071	61	14.7	2,010	16.4	5,647	157*	17.7*	5,490*	16.8*
Education ^b										
High school or less	5,465	182	43.9	5,283	43.2	14,372	453*	51.1*	13,919*	42.6*
Some college	3,284	111	26.7	3,173	26.0	8,933	199*	22.5*	8,734*	26.7*
College degree	2,427	75	18.1	2,352	19.2	6,433	158*	17.8*	6,275*	19.2*
Graduate school	1,465	47	11.3	1,418	11.6	3,840	76*	8.6*	3,764*	11.5*
Marital status ^b										
Married	6,329	194	46.7	6,135	50.2	24,548	616*	69.5*	23,932*	73.2*
Never married	4,668	152	36.6	4,516	36.9	7,317	226*	25.5*	7,091*	21.7*
Divorced, widowed, separated	1,644	69	16.6	1,575	12.9	1,713	44*	5.0*	1,669*	5.1*
Service branch ^b										
Army	6,347	211	50.8	6,136	50.2	15,536	447*	50.5*	15,089*	46.2*
Air Force	3,772	120	28.9	3,652	29.9	10,198	206*	23.3*	9,992*	30.6*
Navy/Coast Guard	2,257	71	17.1	2,186	17.9	6,128	182*	20.5*	5,946*	18.2*
Marine Corps	265	13	3.1	252	2.1	1,716	51*	5.8*	1,665*	5.1*
Service component ^b										
Active duty	6,315	224	54.0	6,091	49.8	18,971	548*	61.9*	18,423*	56.4*
Reserve/National Guard	6,326	191	46.0	6,135	50.2	14,607	338*	38.1*	14,269*	43.6*
Military pay grade ^b										
Officer	3,445	103	24.8	3,342	27.3	9,353	206*	23.3*	9,147*	28.0*
Enlisted	9,196	312	75.2	8,884	72.7	24,225	680*	76.7*	23,545*	72.0*

Table continues

bias. We investigated disordered eating levels before and after deployment to determine the prospective association between stressful life events and the development of eating

disorders. Data for these analyses were from the Millennium Cohort Study, designed to evaluate the long-term effects of military service on health over a period of 21 years (29).

Table 1. Continued

Characteristic	Women					Men				
	Total (n = 12,641)	New-Onset Disordered Eating (n = 415)		No Disordered Eating (n = 12,226)		Total (n = 33,578)	New-Onset Disordered Eating (n = 886)		No Disordered Eating (n = 32,692)	
		No.	% ^a	No.	% ^a		No.	% ^a	No.	% ^a
Occupational codes ^b										
Combat specialists	794	26	6.3	768	6.3	8,440	223	25.2	8,217	25.1
Electronic equipment repair	734	31	7.5	703	5.8	3,472	91	10.3	3,381	10.3
Communications/intelligence	854	29	7.0	825	6.7	2,376	64	7.2	2,312	7.1
Health care	3,003	95	22.9	2,908	23.8	2,422	69	7.8	2,353	7.2
Other technical and allied specialists	265	10	2.4	255	2.1	896	28	3.2	868	2.7
Functional support and administration	4,417	125	30.1	4,292	35.1	5,273	122	13.8	5,151	15.8
Electrical/mechanical equipment repair	620	21	5.1	599	4.9	5,507	144	16.3	5,363	16.4
Craft workers	189	5	1.2	184	1.5	1,205	38	4.3	1,167	3.6
Service and supply	1,098	43	10.4	1,055	8.6	2,789	74	8.4	2,715	8.3
Students, trainees, and other	667	30	7.2	637	5.2	1,198	33	3.7	1,165	3.6
Deployment prior to baseline ^c										
None	10,257	350	84.3	9,907	81.0	18,939	471	53.2	18,468	56.5
1991 Gulf War only	806	25	6.0	781	6.4	2,891	92	10.4	2,799	8.6
Bosnia/Kosovo/southwest Asia only	1,472	38	9.2	1,434	11.7	9,636	275	31.0	9,361	28.6
Both	106	2	0.5	104	0.9	2,112	48	5.4	2,064	6.3
History of life stressors ^{b,d}										
Low/mild	9,175	272*	65.5*	8,903*	72.8*	30,029	758*	85.6*	29,271*	89.5*
Moderate	2,760	109*	26.3*	2,651*	21.7*	3,021	98*	11.1*	2,923*	8.9*
Major	706	34*	8.2*	672*	5.5*	528	30*	3.4*	498*	1.5*
History of diagnosed mental disorder ^b										
No	10,747	307*	74.0*	10,440*	85.4*	31,562	783*	88.4*	30,779*	94.1*
Yes	1,894	108*	26.0*	1,786*	14.6*	2,016	103*	11.6*	1,913*	5.9*
Smoking status ^b										
Nonsmoker	7,977	244	58.8	7,733	63.3	19,671	490	55.3	19,181	58.7
Ever/past smoker	2,790	109	26.3	2,681	21.9	8,448	246	27.8	8,202	25.1
Current smoker	1,874	62	14.9	1,812	14.8	5,459	150	16.9	5,309	16.2
History of alcohol misuse ^{b,e}										
No	11,084	342*	82.4*	10,742*	87.9*	26,925	634*	71.6*	26,291*	80.4*
Yes	1,557	73*	17.6*	1,484*	12.1*	6,653	252*	28.4*	6,401*	19.6*
Special diet for weight loss ^{b,f}										
No	9,937	257*	61.9*	9,680*	79.2*	30,189	689*	77.8*	29 500*	90.2*
Yes	2,704	158*	38.1*	2,546*	20.8*	3,389	197*	22.2*	3,192*	9.8*

* $P < 0.05$ (significantly associated with new-onset disordered eating by using chi-squared tests).

^a Percentages may not sum to 100 because of rounding.

^b Characteristic reported at baseline assessment.

^c Deployment prior to baseline refers to deployment to conflicts before the current deployments in support of the wars in Iraq and Afghanistan. Deployment to Bosnia, Kosovo, or southwest Asia includes any deployment to these contingencies between 1998 and 2000.

^d The Social Readjustment Rating Scale (32).

^e Alcohol misuse is defined as at least 1 positive response to the CAGE questions (i.e., Cutting down, Annoyance by criticism, Guilty feeling, and Eye-openers) (33, 34).

^f Positive response to whether the subject used "special diet programs for weight loss."

MATERIALS AND METHODS

Population and data sources

The population-based sample for the Millennium Cohort was randomly selected from all US military personnel on rosters as of October 2000. By use of a modified Dillman approach that involves minimizing costs and maximizing rewards for responding and that employs a series of reminders to elicit response commencing with a postcard (30), 77,047 of the 214,388 (36%) contacted personnel consented and enrolled in the first panel of the Millennium Cohort Study. This study protocol was approved by the institutional review board of the Naval Health Research Center, and the research was conducted in compliance with all applicable federal regulations governing the protection of human subjects in research (protocol NHRC.2000.007).

Of the 77,047 participants who completed a baseline survey between July 2001 and June 2003, 55,021 (71%) completed a follow-up survey from July 2004 to February 2006 and were included in this study. Of these individuals, 5,342 (9.7%) were excluded who deployed in support of the wars in Iraq and Afghanistan prior to the baseline assessment or who took their survey while deployed, since reporting during deployment would likely differ from reporting following deployment. Additionally, 724 (1.3%) individuals were excluded who did not answer any disordered-eating questions, and 577 (1.0%) were missing demographic or covariate data, leaving a population of 48,378 (87.9%). Of this population, 2,159 (4.5%) individuals met the criteria for disordered eating at baseline, so new-onset disordered eating analyses were performed using 46,219 participants. For the weight-change analyses, an additional 719 people with discrepant heights, 2,039 pregnant women, and 3,446 individuals who did not report either height or weight were excluded from the original analysis population, leaving 42,174 (76.7%).

Demographic and military data were obtained from the electronic personnel files of the Defense Manpower Data Center and included sex, birth date, race/ethnicity, education, marital status, branch of service, service component, military pay grade, military occupation, deployment experience to southwest Asia, Bosnia, or Kosovo between 1998 and 2000, deployment experience in support of the wars in Iraq and Afghanistan from 2001 to 2006, and length of the latter deployment.

Deployed individuals were defined as having completed at least 1 deployment in support of the wars in Iraq and Afghanistan between baseline and follow-up. Exposures reported at follow-up were used to assess combat experiences and were based on affirmative responses to questions that asked whether participants had personally witnessed death due to war, disaster, or tragic event; witnessed instances of physical abuse; and seen dead or decomposing bodies, maimed soldiers or civilians, or prisoners of war or refugees. Individuals reporting these experiences were designated as deployed with combat exposures, while those who did not were classified as deployed without combat exposures.

Baseline characteristics were included in these analyses to investigate whether certain subpopulations were more vulnerable to developing disordered eating or weight changes post-

deployment. History of life stress, which included such items as divorce or having a family member die, was assessed by applying scoring mechanisms from the Holmes and Rahe Social Readjustment Rating Scale (31, 32) and then categorized as low/mild, moderate, or severe. History of a diagnosed mental disorder was determined by the reporting of a physician's diagnosis of depression, schizophrenia or psychosis, manic-depressive disorder, or post-traumatic stress disorder or by the reporting of medication use for anxiety, depression, or stress. Baseline survey questions identified nonsmokers, past smokers, or current smokers. History of alcohol misuse was evaluated by using the CAGE questionnaire (Cutting down, Annoyance by criticism, Guilty feeling, and Eye-openers) (33, 34), which has a test-retest reliability of 0.80–0.95 and an average sensitivity and specificity of 0.71 and 0.90, respectively (33). Finally, self-report at baseline of being on a special diet to lose weight was also examined.

Outcomes

Disordered eating was determined by using 8 survey questions from the Patient Health Questionnaire (35), and a survey-based diagnosis was made by use of criteria from the American Psychiatric Association's *Diagnostic and Statistical Manual of Mental Disorders*, Fourth Edition (1). Although the survey was able to identify individuals with bulimia nervosa, subclinical bulimia nervosa, binge-eating disorder, and subclinical binge-eating disorder, they are reported in the aggregate as "disordered eating." *Bulimia nervosa* was defined as endorsement of binge eating by indicating a loss of control over eating and consuming unusually large amounts of food as often as twice a week for the last 3 months, endorsement of at least 1 compensatory behavior such as vomiting or fasting as often as twice a week, answering "bothered a little" or "bothered a lot" by their weight or how they look, and being at least normal weight (body mass index, ≥ 18.5). *Subclinical bulimia nervosa* was defined the same as bulimia nervosa but with binge episodes and compensatory behaviors at subthreshold frequencies. *Binge-eating disorder* was defined as endorsement of binge eating as often as twice a week for the last 3 months with the absence of inappropriate compensatory behaviors. *Subclinical binge-eating disorder* was defined the same as binge-eating disorder but with binge episodes at subthreshold frequencies. *New-onset disordered eating* was defined as individuals who did not meet the criteria for disordered eating at baseline but met the criteria at follow-up.

Weight change from baseline to follow-up was determined by using self-reported height and weight from the questionnaire and creating a multilevel variable based on percent change in weight: extreme weight loss ($\geq 10\%$ loss), moderate weight loss ($>3\%$ but $<10\%$), stable weight (remained within 3%), moderate weight gain ($>3\%$ but $<10\%$), and extreme weight gain ($\geq 10\%$ gain). Cutpoints were determined by examining percent change in weight in the population, with a 10% change approximating 1 standard deviation from the mean. Women giving birth between baseline and follow-up surveys and participants whose height

Table 2. Odds of New-Onset Disordered Eating Adjusted for the Baseline Demographic, Behavioral, and Occupational Characteristics of Participants ($N = 46,219$), the Millennium Cohort Study, 2001–2006

Characteristic	Women ($n = 12,641$)		Men ($n = 33,578$)	
	Odds Ratio ^a	95% Confidence Interval	Odds Ratio ^a	95% Confidence Interval
Deployment status—deployers only				
Deployed without combat exposures	1.00		1.00	
Deployed with combat exposures	1.78 ^b	1.02, 3.11	1.13	0.83, 1.54
Deployment status—entire study population				
Nondeployed	1.00		1.00	
Deployed without combat exposures	0.83	0.56, 1.23	0.91	0.73, 1.13
Deployed with combat exposures	1.29	0.91, 1.85	0.94	0.77, 1.15
Birth year				
Before 1960	1.00		1.00	
1960–1969	0.91	0.69, 1.21	1.09	0.91, 1.32
1970–1979	1.26	0.92, 1.73	1.19	0.96, 1.49
1980 or later	1.54	0.96, 2.47	1.16	0.74, 1.80
Race/ethnicity				
White, non-Hispanic	1.00		1.00	
Black, non-Hispanic	0.82	0.62, 1.08	0.67 ^b	0.52, 0.88
Other	0.81	0.60, 1.09	0.98	0.81, 1.19
Education ^c				
High school or less	1.00		1.00	
Some college	1.11	0.84, 1.48	0.85	0.69, 1.04
College degree	1.08	0.80, 1.46	0.87	0.72, 1.06
Graduate school	1.20	0.82, 1.75	0.73 ^b	0.56, 0.96
Marital status ^c				
Married	1.00		1.00	
Never married	1.00	0.78, 1.27	1.10	0.92, 1.33
Divorced, widowed, separated	1.34	1.00, 1.79	1.00	0.73, 1.37

Table continues

Table 2. Continued

Characteristic	Women ($n = 12,641$)		Men ($n = 33,578$)	
	Odds Ratio ^a	95% Confidence Interval	Odds Ratio ^a	95% Confidence Interval
Service branch ^c				
Army	1.00		1.00	
Air Force	0.87	0.66, 1.14	0.79 ^b	0.64, 0.96
Navy/Coast Guard	0.93	0.73, 1.24	0.95	0.79, 1.15
Marine Corps	1.31	0.70, 2.37	0.91	0.67, 1.22
Service component ^c				
Reserve/National Guard	1.00		1.00	
Active duty	1.19	0.95, 1.48	1.28 ^b	1.10, 1.49
History of life stressors ^{c,d}				
Low/mild	1.00		1.00	
Moderate	1.12	0.89, 1.43	1.15	0.92, 1.44
Major	1.24	0.84, 1.82	1.75 ^b	1.18, 2.57
History of diagnosed mental disorder ^c				
No	1.00		1.00	
Yes	1.83 ^b	1.45, 2.32	1.88 ^b	1.51, 2.34
History of alcohol misuse ^{c,e}				
No	1.00		1.00	
Yes	1.29	0.99, 1.68	1.44 ^b	1.24, 1.67
Special diet for weight loss ^{c,f}				
No	1.00		1.00	
Yes	2.26 ^b	1.84, 2.78	2.54 ^b	2.15, 2.99

^a Odds ratios and associated 95% confidence intervals are adjusted for all the other variables in the table.

^b Adjusted odds of new-onset disordered eating are significant as shown by associated confidence intervals using logistic regression.

^c The model was adjusted for this characteristic at baseline.

^d The Social Readjustment Rating Scale (32).

^e Alcohol misuse is defined as at least 1 positive response to the CAGE questions (i.e., Cutting down, Annoyance by criticism, Guilty feeling, and Eye-openers) (33, 34).

^f Positive response to whether the subject used “special diet programs for weight loss.”

was more than 2 inches (5.08 cm) discrepant from baseline to follow-up were removed from these analyses.

Statistical analyses

Univariate analyses were completed to investigate unadjusted associations of disordered eating and weight changes with demographic, military, and behavioral risk factors. A model analysis was completed by using a variance inflation factor of 4 or greater to indicate the presence of multicollinearity among the independent variables. Multivariable logistic regression was used to compare the ad-

justed odds of association between deployment and new-onset disordered eating. Additional multivariable models estimated the adjusted odds of new-onset bulimia nervosa, subclinical bulimia nervosa, binge-eating disorder, and subclinical binge-eating disorder. Polychotomous logistic regression was used to compare the adjusted odds of association between deployment and weight change, with stable weight as the outcome reference group. For both disordered eating and weight change investigations, it was decided a priori to let nondeployed personnel be the reference group. Additional models were executed post hoc by using only deployed individuals to compare adjusted odds among those

Table 3. Adjusted Odds of Weight Change^a Among Millennium Cohort Study Women From Baseline (July 2001–June 2003) to Follow-up (July 2004–January 2006) (*N* = 10,186)

Characteristic	Extreme Weight Loss (<i>n</i> = 272)		Moderate Weight Loss (<i>n</i> = 1,260)		Moderate Weight Gain (<i>n</i> = 3,373)		Extreme Weight Gain (<i>n</i> = 1,902)	
	Odds Ratio	95% Confidence Interval	Odds Ratio	95% Confidence Interval	Odds Ratio	95% Confidence Interval	Odds Ratio	95% Confidence Interval
Deployment status— deployers only								
Deployed without combat exposures	1.00		1.00		1.00		1.00	
Deployed with combat exposures	2.35 ^b	1.17, 4.70	1.28	0.91, 1.80	1.05	0.81, 1.37	1.11	0.80, 1.53
Deployment status—entire study population								
Nondeployed	1.00		1.00		1.00		1.00	
Deployed without combat exposures	0.75	0.44, 1.30	1.05	0.82, 1.34	1.00	0.84, 1.20	0.89	0.71, 1.11
Deployed with combat exposures	1.59	0.99, 2.53	1.33 ^b	1.03, 1.73	1.06	0.87, 1.30	1.00	0.78, 1.29
Experienced ≥1 deployments of ≥9 months								
No	1.00		1.00		1.00		1.00	
Yes	0.73	0.33, 1.60	0.91	0.61, 1.35	1.23	0.92, 1.66	0.76	0.52, 1.13
Birth year								
Before 1960	1.00		1.00		1.00		1.00	
1960–1969	0.84	0.60, 1.18	1.11	0.94, 1.32	1.09	0.96, 1.23	1.14	0.97, 1.33
1970–1979	1.23	0.84, 1.81	1.21	0.98, 1.49	1.03	0.89, 1.20	1.26 ^b	1.05, 1.51
1980 or later	1.97 ^b	1.07, 3.61	1.44 ^b	1.03, 2.03	1.07	0.82, 1.39	1.82 ^b	1.37, 2.43
Race/ethnicity								
White, non-Hispanic	1.00		1.00		1.00		1.00	
Black, non-Hispanic	1.04	0.74, 1.46	1.04	0.87, 1.25	1.01	0.88, 1.15	0.96	0.82, 1.13
Other	0.90	0.61, 1.32	1.03	0.86, 1.25	0.97	0.84, 1.11	0.91	0.76, 1.08
Education ^c								
High school or less	1.00		1.00		1.00		1.00	
Some college	0.80	0.57, 1.15	0.90	0.74, 1.09	0.99	0.86, 1.13	0.83 ^b	0.71, 0.98
College degree	0.70	0.45, 1.10	1.05	0.84, 1.31	0.85	0.72, 1.01	0.84	0.69, 1.03
Graduate school	0.66	0.36, 1.22	0.83	0.62, 1.12	0.76 ^b	0.61, 0.94	0.79	0.59, 1.05
Marital status ^c								
Married	1.00		1.00		1.00		1.00	
Never married	0.62 ^b	0.45, 0.85	0.95	0.82, 1.11	0.98	0.87, 1.10	1.11	0.97, 1.28
Divorced, widowed, separated	0.87	0.59, 1.26	0.91	0.74, 1.12	1.15	0.99, 1.33	1.15	0.97, 1.38

Table continues

deployed with reported combat exposures with those deployed without reported combat exposures.

The saturated models for disordered eating and weight change contained all of the variables shown in Table 1. For the disordered-eating models, several first-order multiplicative interactions between combat deployment status and the following variables were investigated on the basis of a priori hypotheses: sex, age, service branch, history of

life stress, history of diagnosed mental disorder, history of alcohol misuse, and self-report of being on a special diet for weight loss. For the weight-change models, the interaction between deployment status and age was tested. Interaction terms were considered significant at $P \leq 0.10$. Because disordered eating and weight changes occur differently in men and women, the study population was stratified by sex. All other interactions examined did not yield significant

Table 3. Continued

Characteristic	Extreme Weight Loss (n = 272)		Moderate Weight Loss (n = 1,260)		Moderate Weight Gain (n = 3,373)		Extreme Weight Gain (n = 1,902)	
	Odds Ratio	95% Confidence Interval	Odds Ratio	95% Confidence Interval	Odds Ratio	95% Confidence Interval	Odds Ratio	95% Confidence Interval
Service branch ^c								
Army	1.00		1.00		1.00		1.00	
Air Force	0.81	0.57, 1.14	0.90	0.76, 1.07	1.08	0.95, 1.23	1.13	0.97, 1.32
Navy/Coast Guard	1.11	0.79, 1.56	1.00	0.83, 1.20	1.07	0.93, 1.23	1.17	1.00, 1.38
Marine Corps ^d			0.68	0.41, 1.13	0.91	0.65, 1.29	0.95	0.64, 1.41
Service component ^c								
Reserve/National Guard	1.00		1.00		1.00		1.00	
Active duty	0.81	0.62, 1.07	0.88	0.77, 1.02	1.01	0.91, 1.12	1.11	0.98, 1.26
Military pay grade ^c								
Officer	1.00		1.00		1.00		1.00	
Enlisted	1.23	0.80, 1.90	1.04	0.84, 1.29	1.15	0.98, 1.35	2.09 ^b	1.70, 2.58
History of life stressors ^{c,e}								
Low/mild	1.00		1.00		1.00		1.00	
Moderate	1.32	0.99, 1.78	1.06	0.90, 1.25	1.14 ^b	1.01, 1.29	1.31 ^b	1.13, 1.51
Major	1.37	0.85, 2.20	0.96	0.72, 1.29	1.16	0.94, 1.44	1.54 ^b	1.22, 1.95
History of diagnosed mental disorder ^c								
No	1.00		1.00		1.00		1.00	
Yes	1.21	0.87, 1.68	1.25 ^b	1.04, 1.50	1.08	0.94, 1.24	1.56 ^b	1.35, 1.83
Smoking status ^c								
Nonsmoker	1.00		1.00		1.00		1.00	
Ever/past smoker	1.43 ^b	1.05, 1.94	1.39 ^b	1.18, 1.64	1.08	0.96, 1.23	1.17 ^b	1.01, 1.35
Current smoker	1.58 ^b	1.12, 2.22	1.27 ^b	1.05, 1.54	0.96	0.83, 1.12	1.10	0.93, 1.30
History of alcohol misuse ^{c,f}								
No	1.00		1.00		1.00		1.00	
Yes	1.32	0.95, 1.84	1.09	0.90, 1.32	0.98	0.85, 1.13	0.82 ^b	0.69, 0.97
Special diet for weight loss ^{c,g}								
No	1.00		1.00		1.00		1.00	
Yes	2.05 ^b	1.56, 2.68	1.18	1.00, 1.38	1.32 ^b	1.17, 1.48	1.99 ^b	1.74, 2.27

^a Weight change was determined by using percent change calculated as the self-reported weight in pounds at follow-up minus the self-reported weight in pounds at baseline assessment, divided by baseline weight. Weight-change categories were defined as follows: extreme weight loss ($\geq 10\%$ loss), moderate weight loss ($>3\%$ but $<10\%$ loss), stable weight (remained within 3%), moderate weight gain ($>3\%$ but $<10\%$ gain), and extreme weight gain ($\geq 10\%$ gain). Stable weight ($n = 3,379$) was the reference category for the polychotomous logistic regression model.

^b Adjusted odds of new-onset disordered eating are significant as shown by associated confidence intervals using polychotomous logistic regression.

^c The model was adjusted for this characteristic at baseline.

^d Small cell sizes prohibited the calculation of an odds ratio and corresponding confidence interval among Marine Corps women in the extreme weight loss group.

^e The Social Readjustment Rating Scale (32).

^f Alcohol misuse is defined as at least 1 positive response to the CAGE questions (i.e., Cutting down, Annoyance by criticism, Guilty feeling, and Eye-openers) (33, 34).

^g Positive response to whether the subject used "special diet programs for weight loss."

P values, indicating no need for further stratification of the population. Confounders were variables that changed the measure of association more than 10% when removed from the

model (36). Variables that were not confounders and not significant in the model using $P < 0.05$ were removed by a manual, backward, stepwise elimination method to create final models.

Additional analyses were conducted among deployed persons only to isolate the effect of combat exposure on the odds of disordered eating and weight change. Data management and statistical analyses were performed by using SAS, version 9.1.3, statistical software (SAS Institute, Inc., Cary, North Carolina).

RESULTS

The cumulative incidence of self-reported disordered eating over 2.7 years, the average time between baseline and follow-up, was 3.3% for women and 2.6% for men. Among women, disordered eating was identified in 5.5% at baseline and 5.2% at follow-up, with 63% of the follow-up cases identified as newly reported. Among men, disordered eating was identified in 4.0% at baseline and 3.9% at follow-up, with 67% of the cases identified as newly reported. The subgroups with a higher proportion of women and men with new-onset disordered eating were those deployed with combat exposures, born in 1980 or later, of white, non-Hispanic race, in the Marine Corps, on active duty, and enlisted personnel or those who reported a history of a past major life stress, a diagnosed mental disorder, misuse of alcohol, or on a special diet for weight loss (Table 1).

Multivariable logistic regression revealed that deployment was not significantly related to new-onset disordered eating in women or men, after adjustment (Table 2). Military pay grade, occupation, deployment to other conflicts prior to baseline, deployment experience longer than 9 months, and smoking status were removed from both models because they were not significant, nor were they confounders. Covariates significantly associated with new-onset disordered eating among women and men were history of a diagnosed mental disorder and self-report of being on a special diet for weight loss. When examining the adjusted multivariable models for the individual eating disorders, we found no significant associations between deployment and new-onset bulimia nervosa, subclinical bulimia nervosa, binge-eating disorder, or subclinical binge-eating disorder (data not shown).

Analyses focusing on the deployed population revealed that women deployed with combat exposures were 1.78 times more likely to develop new-onset disordered eating (95% confidence interval (CI): 1.02, 3.11) (Table 2) and 2.35 times more likely to lose an extreme amount of weight (95% CI: 1.17, 4.70) (Table 3) compared with women deployed without combat exposures. These models were adjusted for the same covariates when modeling the entire population, and these associations were not found among men.

The average weight gain in men and women between baseline and follow-up was 4.7 pounds (2.1 kg) and 5.9 pounds (2.7 kg), respectively, which represented a 2.6% increase among men and a 4.1% increase among women (data not shown). Approximately 33% of women and 48% of men reported stable weight between baseline and follow-up, regardless of deployment status (Table 4). Among women deployed with combat exposures, a greater proportion lost an extreme or moderate amount of weight compared with women deployed without combat exposures and with non-deployed women. Among men deployed with combat ex-

posures, a greater proportion gained a moderate or extreme amount of weight compared with men deployed without combat exposures and with nondeployed men.

The adjusted odds of weight change from baseline to follow-up were explored by using polychotomous logistic regression models for women and men. Occupation and previous deployment experience were removed from the models because they were not statistically significant, nor were they confounders. After adjustment, women deployed with combat exposures were 1.33 times more likely to lose a moderate amount of weight between baseline and follow-up, compared with nondeployed women (95% CI: 1.03, 1.73) (Table 3). Women deployed with combat exposures were 2.35 times more likely to lose an extreme amount compared with women who deployed without combat exposures (95% CI: 1.17, 4.70) (Table 3).

After adjustment, men deployed without combat exposures were significantly less likely to lose a moderate amount of weight (odds ratio = 0.88, 95% CI: 0.78, 0.99) or to gain an extreme amount of weight (odds ratio = 0.82, 95% CI: 0.72, 0.93) compared with nondeployed men (Table 5).

DISCUSSION

Prospective data on the associations between documented stressful and traumatic life events and the development of disordered eating are lacking. This is the first study to prospectively document the impact of deployment on disordered eating or weight change in a large population-based military cohort. No statistically significant overall effect of deployment on increased risk of disordered eating in men and women in comparison with nondeployed personnel was found. However, deployment with combat exposures was associated with a significantly increased risk of new-onset disordered eating and extreme weight loss compared with deployment without combat exposures in women.

These findings suggest that disordered eating and extreme weight change that arise following deployment may be due to the trauma experienced during combat rather than due to deployment itself. The adverse effects of combat trauma have been documented in other investigations of post-traumatic stress disorder (25) and alcohol use (37) before and after deployment. The military selectively deploys its most healthy and fit force, so individuals that do not deploy may be less healthy than those that deploy. Our results support this, since the lowest rates of disordered eating in both men and women were among those who deployed and did not experience combat, and the highest rates were among those who deployed and reported combat exposures. We also found similar cumulative incidence rates of disordered eating over the time span between baseline and follow-up for men and women. Although the rates in women are typically much higher than those in the men in the general population (1), other studies conducted on active duty military populations have reported similar rates between men and women (3, 4). Expected compliance with military weight standards may be an explanation for the high rates in this male population due to concerns over job loss or career advancement.

Table 4. Proportion of Women and Men in Each Weight Change Category^a by Deployment Status (*N* = 42,174), the Millennium Cohort Study, 2001–2006

	Extreme Weight Loss		Moderate Weight Loss		Stable Weight		Moderate Weight Gain		Extreme Weight Gain	
	No.	%	No.	%	No.	%	No.	%	No.	%
Women (<i>n</i> = 10,186)										
Nondeployed	228	2.7	1,035	12.1	2,851	33.4	2,808	32.9	1,620	19.0
Deployed without combat exposures	16	1.9	108	12.5	288	33.3	301	34.8	152	17.6
Deployed with combat exposures	28	3.6	117	15.0	240	30.8	264	33.9	130	16.7
Men (<i>n</i> = 31 988)										
Nondeployed	373	1.6	2,590	10.9	11,247	47.4	7,242	30.5	2,269	9.6
Deployed without combat exposures	55	1.4	415	10.2	1,993	49.1	1,248	30.8	347	8.6
Deployed with combat exposures	54	1.3	447	10.6	1,926	45.8	1,348	32.0	434	10.3

^a Weight change was determined by using percent change calculated as the self-reported weight in pounds at follow-up minus the self-reported weight in pounds at baseline assessment, divided by baseline weight. Weight-change categories were defined as follows: extreme weight loss ($\geq 10\%$ loss), moderate weight loss ($>3\%$ but $<10\%$ loss), stable weight (remained within 3%), moderate weight gain ($>3\%$ but $<10\%$ gain), and extreme weight gain ($\geq 10\%$ gain).

Although it has been documented that stress increases food consumption and encourages unhealthy food choices (15), this study did not find a robust association between deployment and weight gain. It has been suggested that, contrary to the early days of the war when food was limited to ready-to-eat packaged meals, individuals recently deployed have access to large quantities and varieties of food, making weight gain more probable (38). Alternatively, deployed personnel may be more active than their nondeployed counterparts, because deployed personnel are not maintaining families and household activities; they may have more time to devote to fitness activities. Despite the average weight gain observed over an average of 2.7 years, an association was found between deployment with combat exposures and moderate weight loss among women. No notable association between deployment status and weight change was found among men, suggesting that the trauma of deployment with combat exposure may have a greater impact on weight change in women.

We also examined weight change by whether participants had separated from military service. Although the proportion of individuals in most weight-change categories was relatively equal regardless of separation status, we did find that a larger proportion of separated individuals gained an extreme amount of weight. Future follow-up studies of this Millennium Cohort will yield insight into whether separation from military service plays a role in weight change.

We found that men and women who reported being on a diet for weight loss were significantly more likely to experience disordered eating and weight changes. This may be related to the fact that the military maintains weight standards for service members (39, 40), and studies have shown that pressure to meet these standards places personnel at risk for disordered eating and body-image concerns (41, 42).

There are limitations to this study that should be noted. Designed oversampling of women, those previously deployed, and Reserve/National Guard personnel may limit

how representative the Millennium Cohort is of the military or those who deploy. However, investigations of possible biases in the Millennium Cohort baseline sample suggest a representative sample of US military personnel, measured by demographic and health characteristics, and reliable health and exposure reporting (29, 43–50). Personnel that did not respond to the follow-up survey were more likely to be younger, black non-Hispanic or unknown race/ethnicity, Marines, and current smokers and to report post-traumatic stress disorder and depression symptoms or diagnosis at baseline (37), potentially providing a less representative sample at follow-up. In addition, it was not feasible to adjust for deployment location in this study because of the large number of individuals with multiple deployments to various locations, although individuals deployed to different regions may have experienced different frequencies of disordered eating or weight changes.

Another important study limitation was that the sensitive definition of combat exposures was not specific to deployment and did not include items such as receiving small arms fire or being responsible for the death of an enemy combatant. Nonetheless, reporting of experiences, such as witnessing trauma or death due to war, has been shown to be associated with adverse mental health outcomes in previous investigations using the Millennium Cohort and in other studies (22, 25, 37). In addition, the term *new onset* must be interpreted with caution, because disordered eating may be episodic in nature, and we were not able to capture information on disordered eating prior to baseline. Another limitation was the inability to assess purging disorders in this population because of skip rules within the survey that allowed respondents to skip questions concerning the use of inappropriate compensatory behaviors (such as vomiting or overexercising) if they denied binge-eating episodes. These disorders are potentially as severe as and common as bulimia nervosa or binge-eating disorder (51), which would have provided more power to this investigation had we been able to examine them.

Table 5. Adjusted Odds of Weight Change^a Among Millennium Cohort Study Men From Baseline (July 2001–June 2003) to Follow-up (July 2004–January 2006) (N = 31,988)

Characteristic	Extreme Weight Loss ^a (n = 482)		Moderate Weight Loss ^a (n = 3,452)		Moderate Weight Gain ^a (n = 9,838)		Extreme Weight Gain ^a (n = 3,050)	
	Odds Ratio	95% Confidence Interval	Odds Ratio	95% Confidence Interval	Odds Ratio	95% Confidence Interval	Odds Ratio	95% Confidence Interval
Deployment status—deployers only								
Deployed without combat exposures	1.00		1.00		1.00		1.00	
Deployed with combat exposures	0.95	0.62, 1.46	1.17	0.99, 1.38	1.04	0.93, 1.17	1.18	0.98, 1.41
Deployment status—entire study population								
Nondeployed	1.00		1.00		1.00		1.00	
Deployed without combat exposures	0.89	0.66, 1.20	0.88 ^b	0.78, 0.99	0.94	0.87, 1.02	0.82 ^b	0.72, 0.93
Deployed with combat exposures	0.88	0.64, 1.22	0.97	0.86, 1.10	0.98	0.90, 1.07	0.92	0.81, 1.05
Experienced ≥1 deployments of ≥9 months								
No	1.00		1.00		1.00		1.00	
Yes	0.94	0.55, 1.61	1.14	0.93, 1.39	1.13	0.98, 1.29	1.07	0.87, 1.32
Birth year								
Before 1960	1.00		1.00		1.00		1.00	
1960–1969	0.95	0.76, 1.20	1.01	0.92, 1.12	1.07	1.00, 1.15	1.02	0.91, 1.15
1970–1979	1.05	0.78, 1.41	1.16 ^b	1.03, 1.31	1.27 ^b	1.17, 1.39	1.63 ^b	1.42, 1.85
1980 and later	1.76	0.96, 3.22	1.36 ^b	1.02, 1.80	1.54 ^b	1.26, 1.87	4.22 ^b	3.37, 5.30
Race/ethnicity								
White, non-Hispanic	1.00		1.00		1.00		1.00	
Black, non-Hispanic	0.79	0.55, 1.12	0.98	0.86, 1.12	0.97	0.89, 1.07	0.99	0.86, 1.13
Other	0.59 ^b	0.43, 0.81	0.93	0.83, 1.04	1.05	0.98, 1.13	0.96	0.85, 1.08
Education ^c								
High school or less	1.00		1.00		1.00		1.00	
Some college	0.99	0.76, 1.29	0.85 ^b	0.76, 0.94	0.95	0.88, 1.02	0.93	0.83, 1.05
College degree	0.93	0.65, 1.31	0.84 ^b	0.73, 0.97	0.82 ^b	0.74, 0.91	0.64 ^b	0.54, 0.76
Graduate school	1.00	0.63, 1.56	0.87	0.73, 1.05	0.80 ^b	0.70, 0.91	0.68 ^b	0.53, 0.86
Marital status ^c								
Married	1.00		1.00		1.00		1.00	
Never married	1.12	0.86, 1.45	1.11	1.00, 1.24	1.12 ^b	1.05, 1.21	1.36 ^b	1.22, 1.52
Divorced, widowed, separated	1.12	0.74, 1.67	1.06	0.89, 1.26	1.24 ^b	1.10, 1.39	1.11	0.92, 1.34

Table continues

Additionally, because of the large sample size, it was not feasible to complete structured clinical interviews or objective assessments of height and weight at both assessments. However, similar survey-based diagnoses of disordered eating have demonstrated good concurrent validity with interview-based diagnoses (52, 53), and studies have agreed that self-reported height and weight are reliable and valid for large epidemiologic studies (54, 55). Nonetheless, assessment methods were held constant across time. Thus, limita-

tions of self-reported data should not affect evaluation of changes over time in the development of new-onset disordered eating.

Despite these limitations, this study has strengths. Limited work on the prevalence of disordered eating in US military populations has been conducted. This study is the first to prospectively investigate the association between military deployment and disordered-eating behaviors and weight change in a large population-based cohort of women

Table 5. Continued

Characteristic	Extreme Weight Loss ^a (n = 482)		Moderate Weight Loss ^a (n = 3,452)		Moderate Weight Gain ^a (n = 9,838)		Extreme Weight Gain ^a (n = 3,050)	
	Odds Ratio	95% Confidence Interval	Odds Ratio	95% Confidence Interval	Odds Ratio	95% Confidence Interval	Odds Ratio	95% Confidence Interval
Service branch ^c								
Army	1.00		1.00		1.00		1.00	
Air Force	0.87	0.67, 1.13	1.17 ^b	1.06, 1.31	0.98	0.91, 1.05	0.99	0.88, 1.12
Navy/Coast Guard	1.16	0.91, 1.49	1.14 ^b	1.03, 1.27	0.96	0.89, 1.03	0.96	0.86, 1.09
Marine Corps	0.80	0.49, 1.30	0.86	0.71, 1.04	1.01	0.89, 1.14	1.15	0.97, 1.37
Service component ^c								
Reserve/National Guard	1.00		1.00		1.00		1.00	
Active duty	0.89	0.72, 1.09	0.96	0.88, 1.04	1.10 ^b	1.04, 1.17	1.21 ^b	1.10, 1.32
Military pay grade ^c								
Officer	1.00		1.00		1.00		1.00	
Enlisted	1.12	0.80, 1.55	0.99	0.86, 1.13	1.28 ^b	1.17, 1.41	1.81 ^b	1.52, 2.15
History of life stressors ^{c,d}								
Low/mild	1.00		1.00		1.00		1.00	
Moderate	1.13	0.84, 1.52	1.00	0.88, 1.14	1.11 ^b	1.02, 1.22	1.30 ^b	1.14, 1.48
Major	1.28	0.72, 2.29	1.24	0.95, 1.62	0.92	0.75, 1.14	1.29	0.97, 1.71
History of diagnosed mental disorder ^c								
No	1.00		1.00		1.00		1.00	
Yes	1.83 ^b	1.34, 2.49	1.54 ^b	1.33, 1.79	1.40 ^b	1.25, 1.56	1.84 ^b	1.59, 2.13
Smoking status ^c								
Nonsmoker	1.00		1.00		1.00		1.00	
Ever/past smoker	1.41 ^b	1.13, 1.75	1.11 ^b	1.02, 1.22	0.95	0.89, 1.01	1.05	0.95, 1.16
Current smoker	1.57 ^b	1.22, 2.02	1.22 ^b	1.09, 1.35	0.97	0.90, 1.05	1.21 ^b	1.09, 1.35
History of alcohol misuse ^{c,e}								
No	1.00		1.00		1.00		1.00	
Yes	1.38 ^b	1.12, 1.69	1.06	0.97, 1.16	0.95	0.89, 1.01	1.04	0.94, 1.14
Special diet for weight loss ^{c,f}								
No	1.00		1.00		1.00		1.00	
Yes	1.42 ^b	1.07, 1.86	1.20 ^b	1.06, 1.36	1.41 ^b	1.30, 1.53	2.04 ^b	1.82, 2.29

^a Weight change was determined by using percent change calculated as the self-reported weight in pounds at follow-up minus the self-reported weight in pounds at baseline assessment, divided by baseline weight. Weight-change categories were defined as follows: extreme weight loss ($\geq 10\%$ loss), moderate weight loss ($>3\%$ but $<10\%$ loss), stable weight (remained within 3%), moderate weight gain ($>3\%$ but $<10\%$ gain), and extreme weight gain ($\geq 10\%$ gain). Stable weight ($n = 15,166$) was the reference category for the polychotomous logistic regression model.

^b Adjusted odds of new-onset disordered eating are significant as shown by associated confidence intervals using polychotomous logistic regression.

^c The model was adjusted for this characteristic at baseline.

^d The Social Readjustment Rating Scale (32).

^e Alcohol misuse is defined as at least 1 positive response to the CAGE questions (i.e., Cutting down, Annoyance by criticism, Guilty feeling, and Eye-openers) (33, 34).

^f Positive response to whether the subject used "special diet programs for weight loss."

and men. Robust investigations of these associations were allowed by the high participation rates at follow-up, the large sample of both men and women, and demographic,

occupational, and behavioral variables to adjust for possible confounding. Finally, the current study makes a significant contribution to the literature by demonstrating a prospective

association between the trauma of combat exposure and the development of disordered eating in women.

In conclusion, deployment in support of the wars in Iraq and Afghanistan was not associated with new-onset disordered eating or weight change among military personnel. However, findings suggest that the trauma of combat exposure may have greater effects on eating and weight differences in women than men, since significant associations between deployment with combat exposures and disordered eating and weight loss were revealed among women only. In addition, this population, on average, gained weight over the study period. This may reflect trends similar to those in the general population, rather than an association with deployment. As this Millennium Cohort ages, it will become important that future weight change studies adjust for comorbid psychological disorders and distinguish characteristics of those in military service versus those who have transitioned to civilian life. In addition to being the first large-scale epidemiologic study to quantify the association between deployment to war and disordered eating and weight changes, this study highlights the need for continued research in the areas of dieting and weight change among military personnel related to occupational weight standards.

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14. ABSTRACT (maximum 200 words)

Background: Concerns have been raised about the long-term health impacts of recent military deployments to combat environments. Whether such deployments and combat exposure affect frequency of disordered eating behaviors and weight changes is not known.

Results: Overall deployment was not significantly related with new-onset disordered eating in women or men, after adjustment for baseline demographic, military, and behavioral characteristics. However, among deployed women, those reporting combat exposures were 1.78 times more likely to develop new-onset disordered eating and 2.35 times more likely to lose an extreme amount of weight (10% or more of their body weight) compared with women who deployed but had no combat exposures.

Conclusions: Despite no significant overall association between deployment and disordered eating and extreme weight changes, women who deploy with combat exposures represent a special subgroup at significantly higher risk for developing eating problems and weight loss.

14. SUBJECT TERMS
eating disorders, weight gain, weight loss, military personnel, military medicine

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