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Bodybuilding, Energy, and Weight-Loss Supplements Are Associated With Deployment and Physical Activity in U.S. Military Personnel

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PURPOSE: The characteristics of U.S. military personnel who use dietary supplements have not been well described. This study aimed to determine whether deployment experience and physical activity were associated with the use of bodybuilding, energy, or weight-loss supplement among U.S. military personnel.

METHODS: Self-reported data from active-duty, Reserve, and National Guard participants of the Millennium Cohort Study collected from 2007–2008 ($n = 106{,}698$) on supplement use, physical activity, and other behavioral data were linked with deployment and demographic data. We used multivariable logistic regression sex-stratified models to compare the adjusted odds of each type of supplement use among those with deployment experience in support of operations in Iraq or Afghanistan and those engaged in aerobic or strength-training activities.

RESULTS: Overall, 46.7% of participants reported using at least one type of supplement, and 22.0% reported using multiple supplements. Male deployers were more likely to use bodybuilding supplements, whereas female deployers were more likely to use weight-loss supplements. Physically active and younger subjects reported all types of supplement use. Men and women reporting 5 or less hours of sleep per night were more likely to use energy supplements.

CONCLUSIONS: The high prevalence of supplement use and important characteristics found to be associated with their use, including deployment, physical activity, and suboptimal sleep, suggest focus areas for future research and adverse event monitoring.

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KEY WORDS: Dietary Supplements, Exercise, Military Personnel.

INTRODUCTION

The use of dietary supplements in the general U.S. population is common. Recent national surveys indicate that between 52% and 73% of respondents reported using dietary supplements within either the last month or year, respectively (1, 2). These levels of supplement use are consistent with those found among active-duty U.S. military personnel, which have been reported to be 60% as assessed by a Department of Defense Survey of Health-Related Behaviors (3). Dietary supplements have been studied to determine whether they improve physical or mental performance, and in several studies investigators have demonstrated that select supplements improve alertness and enhance physical performance and strength and thereby may be valuable in combat or stressful environments (4–10). The available literature on supplements purported to boost mental performance support a role for caffeine in enhancing cognitive performance, but few others, including ginseng and ginkgo biloba, are likely to be efficacious (11–17). Although it is understandable that some military personnel use supplements to increase performance despite lack of research to substantiate performance enhancement claims, the characteristics of military personnel who use supplements have not been well described.

The Millennium Cohort Study is a 21-year longitudinal study launched in 2001 just prior to the conflicts in Iraq and Afghanistan designed to identify health effects associated with military service (18). The present study explored whether the use of bodybuilding, energy, and weight-loss supplements was associated with deployment experience, physical activity, and demographic, military, and behavioral

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Selected Abbreviations and Acronyms

PTSD = posttraumatic stress disorder

attributes to better understand the characteristics of military personnel who use these specific types of supplements. Furthermore, although not captured in this study, there have been previous reports of adverse health events related to bodybuilding (19, 20), weight loss (21), and energy supplements (22), and findings may identify subgroups for future adverse event monitoring.

METHODS

Study Population

We analyzed data from a cross-sectional sample of a longitudinal study to determine factors associated with supplement use in the Millennium Cohort Study. The Millennium Cohort was originally designed to enroll three panels of participants to be surveyed every 3 years until 2022, starting in 2001 with additional subjects enrolled in 2004 and 2007. Detailed methodology of the study sample can be found elsewhere (18). A total of 77,047 consenting participants enrolled in the first panel from 2001 to 2003; of these, 55,021 (71%) completed their first follow-up questionnaire from 2004 to 2006; and 54,790 (71%) completed the next follow-up questionnaire from 2007 to 2008. A total of 31,110 participants consented and enrolled in the second panel from 2004 to 2006; of these, 17,152 (55%) completed a follow-up questionnaire from 2007 to 2008. A total of 43,440 consenting participants enrolled in the third panel from 2007 to 2008. The current study included participants from all three panels who completed a questionnaire during the 2007–2008 survey cycle. All participants provided informed, voluntary consent before enrollment in the study, which was approved by the institutional review board at the Naval Health Research Center (protocol number NHRC.2000.0007).

Data Collection and Exposures

For this study, information on independent and dependent variables were collected from the 2007 to 2008 survey. Electronic military personnel files maintained by Defense Manpower Data Center containing demographic, military, and occupational information were linked to each participant, reflecting their status during the 2007–2008 survey cycle, including date of birth, marital status, sex, race/ethnicity, occupation, service branch, service component, education level, and pay grade.

The variables of interest were deployment experience and physical activity. Deployment experience in support of operations in Iraq and Afghanistan was determined using in- and out-of-theater dates from electronic military deployment data provided by Defense Manpower Data Center. Individuals with deployment experience had deployed at least once in support of operations in Iraq and Afghanistan at any time between study enrollment and submission of their 2007–2008 survey, or submitted their 2007–2008 survey during a deployment, and were compared with participants who never deployed or had not yet deployed at the time of their 2007–2008 survey submission.

Physical activity level was determined by use of the Millennium Cohort questionnaire in which participants were asked to estimate average number of minutes per day and days per week spent in each of three categories: strength training, vigorous, and moderate or light physical activity. For each activity, participants were given the option to indicate "none" or "cannot physically do." Strength training was described as "strength training or work that strengthens your muscles (e.g., lifting/pushing/pulling weights)." Vigorous physical activity was described as "vigorous exercise or work that causes heavy sweating or large increases in breathing or heart rate (e.g., running, active sports, marching, biking)." Moderate or light physical activity was described as "moderate or light exercise or work that causes light sweating or slight increases in breathing or heart rate (e.g., walking, cleaning, slow jogging)."

Participants were classified into one of three categories for each type of activity on the basis of guidelines from the Healthy People 2010 objectives (23). Strength training activity level was classified as (1) "active," defined as 2 or more days per week of activity; (2) "inactive," defined as those who did less than 2 days per week of strength training; and (3) "cannot physically do," if they so indicated. Vigorous and moderate to light physical activity were combined into one aerobic variable with three categories: (1) "active," defined as either 30 minutes or more per day on 5 or more days per week of moderate/light activity, or 20 minutes or more per day on 3 or more days per week of vigorous exercise (23); (2) "inactive," defined as those who did not meet the aforementioned criteria; and (3) "cannot physically do," if they so indicated.

Other self-reported covariate data included height and weight which were converted to body mass index (kg/m^2) (24), trouble sleeping, hours of sleep per night (25–27), problem drinking as defined by the Patient Health Questionnaire, with at least 1 affirmative answer of 5 items indicating a positive screen, and smoking status. Positive screens for posttraumatic stress disorder (PTSD) were evaluated with the PTSD Patient Checklist-Civilian Version (28), whereas positive screens for disordered eating, anxiety or panic syndrome, and major depressive disorder

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TABLE 1. Characteristics of Millennium Cohort participants by gender, 2007–2008

	Total $N = 106,698$		Men $n = 72,718$		Women $n = 33,980$	
Characteristics	*n*	(%)	*n*	(%)	*n*	(%)
Deployment experience*						
Nondeployed	47,438	(44.5)	28,692	(39.5)	18,746	(55.2)
Deployed	59,260	(55.5)	44,026	(60.5)	15,234	(44.8)
Strength training†						
Not active	40,331	(37.8)	26,319	(36.2)	14,012	(41.2)
Active	61,969	(58.1)	44,031	(60.6)	17,938	(52.8)
Cannot do	4,037	(3.8)	2,131	(2.9)	1,906	(5.6)
Missing	361	(0.3)	237	(0.3)	124	(0.4)
Aerobic activity‡						
Not active	35,562	(33.3)	24,636	(33.9)	10,926	(32.2)
Active	55,530	(52.0)	38,465	(52.9)	17,065	(50.2)
Cannot do	5,069	(4.8)	2,521	(3.5)	2,548	(7.5)
Missing	10,537	(9.9)	7,096	(9.8)	3,441	(10.1)
Birth year						
Pre–1960	12,913	(12.1)	9,856	(13.6)	3,057	(9.0)
1960–1969	22,640	(21.2)	17,153	(23.6)	5,487	(16.1)
1970–1979	27,847	(26.1)	18,962	(26.1)	8,885	(26.1)
1980 and later	43,298	(40.6)	26,747	(36.8)	16,551	(48.7)
Race/ethnicity						
White/non-Hispanic	76,962	(72.1)	54,699	(75.2)	22,263	(65.5)
Black/non-Hispanic	11,998	(11.2)	6,188	(8.5)	5,810	(17.1)
Hispanic	7,611	(7.1)	4,949	(6.8)	2,662	(7.8)
Asian/Pacific Islander	7,466	(7.0)	5,226	(7.2)	2,240	(6.6)
American Indian	1,479	(1.4)	886	(1.2)	593	(1.7)
Other	1,182	(1.1)	770	(1.1)	412	(1.2)
Marital status						
Married	36,980	(34.7)	22,717	(31.2)	14,263	(42.0)
Never married	61,697	(57.8)	45,968	(63.2)	15,729	(46.3)
Divorced/separated/widowed	8,021	(7.5)	4,033	(5.5)	3,988	(11.7)
Military pay grade						
Enlisted	83,302	(78.1)	56,396	(77.6)	26,906	(79.2)
Officer	23,396	(21.9)	16,322	(22.4)	7,074	(20.8)
Education						
Less than high school	9,606	(9.0)	6,710	(9.2)	2,896	(8.5)
High school diploma	49,297	(46.2)	33,519	(46.1)	15,778	(46.4)
Some college	15,921	(14.9)	10,940	(15.0)	4,981	(14.7)
Bachelor's degree	20,437	(19.2)	13,792	(19.0)	6,645	(19.6)
Postgraduate degree	11,437	(10.7)	7,757	(10.7)	3,680	(10.8)
Occupation						
Combat specialist	18,008	(16.9)	15,925	(21.9)	2,083	(6.1)
Health care	12,346	(11.6)	5,031	(6.9)	7,315	(21.5)
Functional support	21,351	(20.0)	11,189	(15.4)	10,162	(29.9)
Construction	3,132	(2.9)	2,508	(3.4)	624	(1.8)
Other	51,861	(48.6)	38,065	(52.3)	13,796	(40.6)
Service branch						
Army	45,402	(42.6)	30,386	(41.8)	15,016	(44.2)
Navy/Coast Guard	19,392	(18.2)	12,769	(17.6)	6,623	(19.5)
Air Force	32,224	(30.2)	21,126	(29.1)	11,098	(32.7)
Marine Corps	9,680	(9.1)	8,437	(11.6)	1,243	(3.7)
Service component						
Active duty	64,116	(60.1)	44,755	(61.5)	19,361	(57.0)
Reserve/National Guard	42,582	(39.9)	27,963	(38.5)	14,619	(43.0)
Body mass index						
Underweight	891	(0.8)	293	(0.4)	598	(1.8)
Healthy weight	38,544	(36.1)	20,533	(28.2)	18,011	(53.0)
Overweight	49,737	(46.6)	38,234	(52.6)	11,503	(33.9)

(*Continued*)

TABLE 1. (Continued)

	Total $N = 106,698$		Men $n = 72,718$		Women $n = 33,980$	
Characteristics	*n*	(%)	*n*	(%)	*n*	(%)
Obese	17,526	(16.4)	13,658	(18.8)	3,868	(11.4)
Amount of sleep						
⩽5 hours	21,533	(20.2)	14,627	(20.1)	6,906	(20.3)
6 hours	33,824	(31.7)	23,895	(32.9)	9,929	(29.2)
7–8 hours	45,270	(42.4)	31,092	(42.8)	14,178	(41.7)
⩾9 hours	6,071	(5.7)	3,104	(4.3)	2,967	(8.7)
Trouble sleeping						
No	73,041	(68.5)	51,642	(71.0)	21,399	(63.0)
Yes	33,657	(31.5)	21,076	(29.0)	12,581	(37.0)
Problem drinker[§]						
No	94,373	(88.4)	63,447	(87.3)	30,926	(91.0)
Yes	12,325	(11.6)	9,271	(12.7)	3,054	(9.0)
Smoking status						
Nonsmoker	61,904	(58.0)	40,654	(55.9)	21,250	(62.5)
Past smoker	15,055	(14.1)	11,189	(15.4)	3,866	(11.4)
Current smoker	29,739	(27.9)	20,875	(28.7)	8,864	(26.1)
Disordered eating						
No	102,848	(96.4)	70,220	(96.6)	32,628	(96.0)
Yes	3,850	(3.6)	2,498	(3.4)	1,352	(4.0)
PTSD symptoms						
No	99,391	(93.2)	68,071	(93.6)	31,320	(92.2)
Yes	7,307	(6.8)	4,647	(6.4)	2,660	(7.8)
Panic/anxiety symptoms						
No	101,513	(95.1)	69,742	(95.9)	31,771	(93.5)
Yes	5,185	(4.9)	2,976	(4.1)	2,209	(6.5)
Depression						
No	101,527	(95.2)	69,533	(95.6)	31,994	(94.2)
Yes	5,171	(4.8)	3,185	(4.4)	1,986	(5.8)
Panel[‖]						
Panel 1	51,276	(48.1)	37,856	(52.1)	13,420	(39.5)
Panel 2	15,788	(14.8)	9,495	(13.1)	6,293	(18.5)
Panel 3	39,634	(37.1)	25,367	(34.9)	14,267	(42.0)

PTSD = posttraumatic stress disorder.
All characteristics listed in the table were assessed at the participant's 2007–2008 survey and were significantly associated with sex at $p < 0.05$.
*Deployment experience means having deployed in support of the operations in Iraq or Afghanistan any time from study enrollment to the 2007–2008 survey cycle.
[†]Meets the standard from Healthy People 2010 of ⩾2 days/week of strength training activity.
[‡]Meets the standards from Healthy People 2010 of ⩾30 minutes/day on ⩾5 days/week of moderate/light activity, or ⩾20 minutes/day on ⩾3 days/week of vigorous activity.
[§]Problem drinkers were defined as those who provided at least one affirmative answer to the 5-item Patient Health Questionnaire.
[‖]Panel number indicates enrollment year into the Cohort. Panel 1 was enrolled from 2001 to 2003, panel 2 was enrolled from 2004 to 2006, and panel 3 was enrolled from 2007 to 2008.

were assessed by use of the Patient Health Questionnaire (29–31).

Outcomes

In 2007, a new question about supplement use in the past year was added to the Millennium Cohort questionnaire which asked, "Have you taken any of the following supplements in the last 12 months?" Response options of yes or no were available for the following items: "bodybuilding supplements (such as amino acids, weight-gain products, creatine)," "energy supplements (such as energy drinks, pills, or energy-enhancing herbs)," or "weight-loss supplements." Reported use of each of the three supplement types (yes/no) were analyzed as separate outcomes.

Statistical Analyses

The study population was stratified by sex because type of supplement use differs by sex (1, 32). Characteristics of participants who self-reported use of energy, bodybuilding, or weight-loss supplements were descriptively compared with participants who did not report use of these supplements. Logistic regression was used to examine adjusted odds of supplement use in relation to deployment, physical activity, and demographic, military, and behavioral characteristics in bivariable and multivariable models. Regression diagnostics were conducted to assess multicollinearity. A variance inflation factor of four or greater indicated multicollinearity was likely. Adjusted odds ratios and 95% confidence intervals were calculated, and all analyses were

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conducted using SAS software, version 9.2 (SAS Institute, Inc., Cary, NC).

RESULTS

A total of 115,382 participants completed questionnaires during the 2007–2008 survey cycle. Subjects were excluded from this analysis because of internally contradictory responses ($n = 3$) or missing data on supplement use ($n = 2{,}371$), physical activity ($n = 284$), demographic or occupational information ($n = 2{,}040$), or mental health information ($n = 3{,}986$), leaving 106,698 study participants included in analyses.

Nearly one-half of the study population (46.7%, $n = 49{,}823$) reported use of at least one type of supplement specified in the questionnaire. Of the total population, 17.3% reported use of bodybuilding supplements (22.8% of men, 5.3% of women), 38.0% reported use of energy supplements (40.5% of men, 35.5% of women), and 19.4% reported use of weight-loss supplements (15.9% of men, 26.9% of women). Supplement use was more common in men than women except for weight-loss supplements, and energy supplements were the most frequently reported supplements used by both sexes.

Compared with women in this study, a greater proportion of men were deployed, actively participating in strength training and aerobic activity, older, white/non-Hispanic, never married, officers, combat specialists, serving on active duty or in the Marine Corps ($p < 0.05$; Table 1). In addition, more men were overweight or obese, past or current smokers, problem drinkers, or reported sleeping 6 to 8 hours, and fewer men screened positive for mental disorders compared with women ($p < 0.05$; Table 1).

Table 2 presents comparisons of characteristics of male and female supplement users across supplement type. Among men who were using bodybuilding supplements compared with those using energy or weight-loss supplements, a greater proportion were deployed, engaged in strength training or aerobic activity, born in 1980 or later, married, combat specialists, in the Marine Corps, on active duty, and of healthy weight. Men using energy or weight-loss supplements compared with those using bodybuilding supplements engaged in less physical activity, were no longer married, were in the Reserve or National Guard, were overweight or obese, reported more depression symptoms, and slept ⩽5 hours in a 24-hour period. Women and men using bodybuilding supplements had the same characteristics when compared with those using energy or weight-loss supplements, except women using bodybuilding supplements were more likely to be born between 1970 and 1979 and be in other occupations (e.g., craft workers other than construction, electrical/mechanical equipment repair, and electronic equipment repair).

Deployment experience, younger age, and problem drinking were significantly associated with increased adjusted odds of reporting bodybuilding, energy, and weight-loss supplement use compared with no reported use of these supplements in sex-stratified multivariable models (Table 3). Men and women using at least one type of supplement were significantly more likely to use additional types of supplements. Aerobically active individuals were significantly more likely to use energy or weight-loss supplements than aerobically inactive participants. Individuals engaged in active strength training were significantly more likely to use all three supplement types, with odds for use of bodybuilding supplements being the largest. Individuals reporting they could not perform strength training were more likely to use bodybuilding supplements, whereas individuals reporting they could not perform aerobic activity were less likely to use bodybuilding supplements. Marine Corps men were significantly more likely than Army men to use all three supplement types, whereas Marine Corps women were only significantly more likely than Army women to use weight-loss supplements. Individuals reporting trouble sleeping and those getting ⩽5 hours or 6 hours of sleep were significantly more likely to use energy and weight-loss supplements. For both sexes, mental health disorders, including depression, and panic or anxiety disorders were inconsistently associated with some types of supplement use.

DISCUSSION

This is the first study to explore supplement use in both active-duty and Reserve/National Guard personnel from all branches of the U.S. military. Our evaluation demonstrates that nearly half of military personnel report use of bodybuilding, energy, or weight-loss supplements. Findings that emerged from this study were that subjects more likely to report supplement use were deployed in support of the operations in Iraq and Afghanistan, physically active, younger, screened positive for problem drinking, and reported suboptimal nightly sleep.

In comparison with an active-duty military population, our prevalence of bodybuilding and weight-loss supplements were remarkably similar (3) but the active duty study asked about "performance-enhancing supplements" rather than "energy supplements," making a comparison difficult. Although our prevalence is much greater compared with the 2002 Health and Diet Survey's report of adults' use of creatine and Ephedra or Ma haung (weight-loss supplements) (2), our prevalence of bodybuilding and energy supplements are slightly lower compared with young athletes using creatine (33) and college students using energy drinks

(34). However, the use of weight-loss supplements in our population appeared to be relatively comparable to a national survey (35). Although slightly lower in comparison with college students and young athletes, possible reasons why the prevalence of supplements examined in this study may be high with respect to the general population include a relatively younger age and the requirements for military personnel to meet weight and fitness standards. In addition, these types of supplements are widely available on posts and bases (commissaries and exchanges) (36) and may be offered for slightly cheaper costs than civilian stores.

Deployment experience was related to all types of supplement use examined, regardless of sex. Although this study did not collect reasons for supplement use, individuals who deploy may be more likely to use weight-loss supplements to either obtain or maintain fit-for-duty standards as required by their respective military service. Bodybuilding supplements may be used because deployers seek to maintain strength for carrying heavy loads, and energy supplements may be used to potentially increase and maintain alertness during long shifts. Interestingly, in a subanalysis of deployers only, we did not find a statistically significant difference in reported physical health among deployed personnel reporting any of the supplements examined when compared with deployed personnel not reporting supplement use.

We found that aerobic activity and strength training were associated with supplement use. Although this finding has been observed in civilian populations (1), it is noteworthy in this military population because of factors such as deployment, physical fitness standards, and physically demanding occupations. Also, because this study sample comprised both active-duty and Reserve/National Guard personnel, all were not equally physically active. In addition, participants who reported they could not engage in strength training were more likely to use bodybuilding supplements, whereas those who could not perform aerobic activities were less likely to use them. A potential explanation for these observations is those who are not able to strength train may still wish to maintain muscle mass, whereas those unable to perform aerobic activities may be challenged with excess body weight and not want additional bulk.

Factors not previously identified as predictors of dietary supplement use were associated with supplement use in this military population. Problem drinking was consistently associated with all types of supplement use and most strongly with energy supplements. Although the energy supplement question did not ask about the specific kind of energy supplements or the reasons for using these supplements, it is possible that energy drinks or other energy enhancers are being consumed in conjunction with alcohol, which has been observed in other studies to create a high-risk situation if the perception of intoxication is lowered by the feeling of increased energy (37, 38). Decreasing amount of sleep per night was also independently and significantly associated with increased use of energy supplements, with those reporting the least amount of sleep (5 hours or less per night) having the greatest likelihood for energy supplement use (odds ratio = 1.37 for men and odds ratio = 1.29 for women). Because caffeine is frequently present in energy and weight-loss supplements (39, 40), individuals may be attempting to compensate for inadequate sleep by using such supplements, or perhaps their use may interfere with sleep.

A positive screen for depression was reported less frequently by men who used bodybuilding supplements and more frequently by women who used weight-loss supplements. The former finding may be reflective of the relationship observed between increased physical activity and decreased depression found in other studies (41, 42), whereas the latter finding may be consistent with previous work showing depression as associated with body weight variability (43). The relationship between screening positive for mental disorders and supplement use is not well documented in the literature, although small case studies have reported potential associations between adverse mental health events and energy drink consumption (44, 45). In this study, there were no apparent consistent associations between PTSD and any type of supplement use.

Other military factors, including service branch, were associated with supplement use, with male Marines consuming more of all types of supplements and female Marines using more weight-loss supplements. Each service has different body composition and physical performance standards, of which Marine Corps standards are the most stringent (46–49). This finding could indicate that Marines use supplements to help meet these rigorous standards. Military occupation also affected dietary supplement use, with service members from combat specialties, especially men, using more bodybuilding and energy supplements, and less weight-loss supplements, perhaps with the intention of increasing job performance. Although our study did not collect reasons for supplement use, in a recent study on U.S. Army soldiers (50), researchers found that promoting general health, energy, muscle strength, and performance were the top reasons for using supplements.

There were several limitations to this study. Self-reported data were used to measure both physical activity and supplement use and may over- or under-represent actual behavior. Although our survey measure of physical activity has not been validated, we used established guidelines from the Healthy People 2010 objectives (23) to classify activity levels. Also, studies in which the authors used a variety of survey instruments have found self-reported physical activity to be generally valid and reliable (51, 52). The supplement questions could not be objectively confirmed and did not measure exact amount, frequency, or duration of use, so a dose–response relationship could

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TABLE 2. Characteristics of Millennium Cohort participants who reported use of at least one supplement type, 2007–2008

	Men (n = 35,136)			Women (n = 14,687)		
	Bodybuilding* (n = 16,616) %	Energy† (n = 29,481) %	Weight loss (n = 11,587) %	Bodybuilding (n = 1,799) %	Energy (n = 11,034) %	Weight loss (n = 9,130) %
Type of supplement‡						
Bodybuilding	N/A	44.1	50.4	N/A	12.5	11.5
Energy	78.2	N/A	78.5	76.8	N/A	63.3
Weight loss	35.2	30.9	N/A	58.5	52.3	N/A
Deployment experience§						
Nondeployed	27.5	32.2	29.7	44.4	48.1	49.0
Deployed	72.5	67.8	70.3	55.6	51.9	51.0
Strength training‖						
Not active	14.5	27.6	26.7	22.2	35.8	38.3
Active	83.9	69.7	70.7	73.9	59.2	56.4
Cannot do	1.4	2.5	2.4	3.4	4.6	5.0
Missing volume	0.2	0.3	0.2	0.5	0.3	0.3
Aerobic activity¶						
Not active	25.9	29.2	28.0	25.2	28.4	29.2
Active	63.9	58.7	60.0	60.8	55.4	54.1
Cannot do	1.9	3.1	3.4	4.5	6.4	7.0
Missing volume	8.3	9.0	8.6	9.5	9.8	9.7
Birth year						
Pre–1960	2.3	5.0	4.7	3.4	4.3	5.2
1960–1969	11.7	16.6	17.7	11.6	12.7	15.3
1970–1979	27.0	28.1	29.4	29.6	26.3	27.5
1980 and later	59.0	50.3	48.1	55.5	56.7	52.0
Race/ethnicity						
White/non-Hispanic	72.6	73.1	70.7	59.5	64.1	64.2
Black/non-Hispanic	9.2	9.3	9.6	17.2	17.0	17.9
Hispanic	8.5	8.2	10.1	11.8	9.2	8.9
Asian/Pacific Islander	7.0	6.7	6.5	8.1	6.3	5.7
American Indian	1.5	1.5	1.7	1.9	2.3	2.1
Other	1.2	1.1	1.3	1.5	1.2	1.2
Marital status						
Married	47.2	40.7	37.7	50.8	48.0	43.4
Never married	48.4	54.2	57.2	36.0	39.9	43.9
Divorced/separated/ widowed	4.4	5.1	5.1	13.2	12.1	12.7
Military pay grade						
Enlisted	84.1	85.5	86.5	83.5	86.7	87.1
Officer	15.9	14.5	13.5	16.5	13.3	12.9
Education						
Less than high school	10.1	9.9	9.3	9.7	9.8	9.2
High school diploma	60.4	57.8	59.6	51.0	54.8	53.4
Some college	9.0	12.5	11.8	13.5	14.0	15.5
Bachelor's degree	15.8	14.8	14.1	19.0	15.7	15.6
Postgraduate degree	4.7	5.1	5.1	6.8	5.7	6.2
Occupation						
Combat specialist	23.4	21.8	20.9	5.7	6.1	5.6
Health care	6.3	5.9	6.6	18.1	18.2	18.5
Functional support	13.5	14.1	14.9	26.2	28.8	30.6
Construction	1.3	1.4	1.2	0.6	0.6	0.7
Other	55.5	56.8	56.3	49.3	46.2	44.7
Service branch						
Army	41.3	42.5	45.1	48.2	45.8	46.8
Navy/Coast Guard	14.7	16.6	16.5	18.2	19.3	20.4
Air Force	25.8	24.6	21.9	4.6	30.3	28.2
Marine Corps	18.2	16.4	16.4	28.9	4.5	4.6

(*Continued*)

TABLE 2. (Continued)

	Men (n = 35,136)			Women (n = 14,687)		
	Bodybuilding* (n = 16,616) %	Energy† (n = 29,481) %	Weight loss (n = 11,587) %	Bodybuilding (n = 1,799) %	Energy (n = 11,034) %	Weight loss (n = 9,130) %
Service component						
Active duty	71.2	68.1	69.3	63.0	61.5	62.0
Reserve/National Guard	28.8	31.9	30.7	37.0	38.5	38.0
Body mass index						
Underweight	0.4	0.4	0.1	2.7	1.6	0.5
Healthy weight	33.1	28.7	9.4	58.0	51.7	36.5
Overweight	52.7	53.1	58.5	30.9	35.9	45.7
Obese	13.8	17.8	31.9	8.4	10.8	17.4
Amount of sleep						
⩽5 hours	23.0	25.5	28.4	24.7	26.1	26.8
6 hours	33.5	34.5	34.8	30.5	31.3	31.1
7–8 hours	38.6	35.5	32.3	35.6	33.9	33.4
⩾9 hours	4.9	4.6	4.5	9.1	8.7	8.7
Trouble sleeping						
No	68.3	65.3	61.5	56.8	54.2	53.0
Yes	31.7	34.7	38.5	43.2	45.8	47.0
Problem drinker#						
No	81.9	81.9	81.5	85.2	85.3	86.4
Yes	18.1	18.1	18.5	14.8	14.7	13.6
Smoking status						
Nonsmoker	54.8	51.1	52.1	60.5	54.7	55.7
Past smoker	11.4	12.7	13.3	10.2	10.2	11.3
Current smoker	33.8	36.3	34.6	29.3	35.1	33.0
Disordered eating						
No	96.6	96.0	92.9	94.9	94.8	93.1
Yes	3.4	4.0	7.1	5.1	5.2	6.9
PTSD symptoms						
No	93.3	91.9	90.4	89.2	89.4	89.4
Yes	6.7	8.1	9.6	10.8	10.6	10.6
Panic/anxiety symptoms						
No	96.2	95.2	94.6	92.1	91.3	91.5
Yes	3.8	4.8	5.4	7.9	8.7	8.5
Depression						
No	96.0	94.7	93.6	93.4	92.4	91.7
Yes	4.0	5.3	6.4	6.6	7.6	8.3
Panel**						
Panel 1	28.8	37.8	39.8	30.9	31.9	36.6
Panel 2	15.8	15.4	15.2	21.7	19.9	19.2
Panel 3	55.4	46.7	45.0	47.4	48.3	44.2

N/A = not applicable; PTSD = posttraumatic stress disorder.
*Bodybuilding supplements are defined as amino acids, weight-gain products, and products like creatine.
†Energy supplements are defined as energy drinks, pills, or energy-enhancing herbs.
‡For the first 4 rows, the columns do not add up to 100% because participants were able to endorse more than one type of supplement, so supplement categories were not mutually exclusive.
§Deployment experience means having deployed in support of the operations in Iraq or Afghanistan any time from study enrollment to the 2007–2008 survey cycle.
¶Meets the standards from Healthy People 2010 of ⩾30 minutes/day on ⩾5 days/week of moderate/light activity, or ⩾20 minutes/day on ⩾3 days/week of vigorous activity.
‖Meets the standard from Healthy People 2010 of ⩾2 days/week of strength training activity.
#Problem drinkers were defined as those who provided at least one affirmative answer to the 5-item Patient Health Questionnaire.
**Panel number indicates enrollment year into the Cohort. Panel 1 was enrolled from 2001 to 2003, panel 2 was enrolled from 2004 to 2006, and panel 3 was enrolled from 2007 to 2008.

not be estimated, nor could reasons for their use be ascertained. In addition, 2371 subjects (2% of those completing a 2007–2008 survey) did not answer any of the supplement use questions. A greater proportion of subjects who skipped the supplement use questions did not meet the criteria for being active in strength training or aerobic activity, were underweight, and slept 5 hours or less per night. These missing data may have biased our findings in either direction because we cannot know whether those with missing data were supplement users. Furthermore, because we were only able to establish whether the participant reported use of the supplement over the last 12 months,

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TABLE 3. Odds of each type of supplement use among Millennium Cohort participants adjusted for all covariates shown, 2007–2008

	Men (n = 72,718)			Women (n = 33,980)		
	Bodybuilding* Odds ratio (95% CI)	Energy† Odds ratio (95% CI)	Weight loss Odds ratio (95% CI)	Bodybuilding Odds ratio (95% CI)	Energy Odds ratio (95% CI)	Weight-loss Odds ratio (95% CI)
Deployment experience‡						
Nondeployed	1.00	1.00	1.00	1.00	1.00	1.00
Deployed	1.25 (1.19, 1.31)	1.06 (1.02, 1.10)	1.19 (1.13, 1.25)	1.14 (1.03, 1.27)	1.15 (1.09, 1.21)	1.16 (1.10, 1.23)
Birth Year						
Pre–1960	1.00	1.00	1.00	1.00	1.00	1.00
1960–1969	2.06 (1.82, 2.32)	1.60 (1.49, 1.72)	1.44 (1.29, 1.60)	1.28 (0.95, 1.73)	1.39 (1.23, 1.58)	1.46 (1.28, 1.66)
1970–1979	3.47 (3.08, 3.90)	2.26 (2.10, 2.42)	1.72 (1.54, 1.91)	1.67 (1.25, 2.23)	1.64 (1.45, 1.85)	1.44 (1.27, 1.64)
1980 and later	4.86 (4.29, 5.50)	2.48 (2.29, 2.69)	1.88 (1.67, 2.12)	1.48 (1.10, 2.00)	1.69 (1.48, 1.92)	1.31 (1.14, 1.49)
Strength training§						
Not active	1.00	1.00	1.00	1.00	1.00	1.00
Active	3.48 (3.30, 3.67)	1.12 (1.07, 1.16)	1.06 (1.00, 1.12)	2.29 (2.02, 2.60)	1.23 (1.16, 1.31)	1.11 (1.04, 1.18)
Cannot do	1.61 (1.34, 1.94)	0.92 (0.81, 1.05)	0.76 (0.63, 0.91)	1.59 (1.14, 2.23)	0.95 (0.81, 1.10)	0.81 (0.69, 0.95)
Missing	1.53 (0.99, 2.39)	1.15 (0.84, 1.58)	1.11 (0.70, 1.75)	2.94 (1.40, 6.15)	1.12 (0.72, 1.76)	0.85 (0.52, 1.41)
Aerobic activity¶						
Not active	1.00	1.00	1.00	1.00	1.00	1.00
Active	1.00 (0.95, 1.05)	1.13 (1.08, 1.18)	1.15 (1.09, 1.21)	1.00 (0.89, 1.14)	1.14 (1.07, 1.21)	1.15 (1.08, 1.23)
Cannot do	0.67 (0.57, 0.80)	1.02 (0.90, 1.15)	1.10 (0.94, 1.29)	0.71 (0.53, 0.96)	0.86 (0.75, 0.98)	0.91 (0.71, 1.05)
Missing	0.92 (0.85, 0.99)	1.00 (0.94, 1.07)	1.04 (0.96, 1.14)	0.93 (0.78, 1.13)	1.05 (0.95, 1.15)	1.07 (0.97, 1.19)
Bodybuilding supplement user						
No	N/A	1.00	1.00	N/A	1.00	1.00
Yes	N/A	5.38 (5.14, 5.63)	2.78 (2.64, 2.93)	N/A	4.97 (4.39, 5.62)	2.46 (2.20, 2.75)
Energy supplement user						
No	1.00	N/A	1.00	1.00	N/A	1.00
Yes	5.47 (5.23, 5.73)	N/A	4.62 (4.38, 4.88)	5.03 (4.45, 5.69)	N/A	5.68 (5.36, 6.02)
Weight loss supplement user						
No	1.00	1.00	N/A	1.00	1.00	N/A
Yes	2.84 (2.70, 3.00)	4.59 (4.35, 4.85)	N/A	2.50 (2.23, 2.80)	5.67 (5.35, 6.01)	N/A
Education						
Less than high school	1.00	1.00	1.00	1.00	1.00	1.00
High school diploma	0.93 (0.86, 1.00)	1.06 (1.00, 1.13)	1.16 (1.06, 1.26)	0.88 (0.73, 1.05)	0.97 (0.88, 1.07)	0.99 (0.89, 1.10)
Some college	0.86 (0.79, 0.95)	1.01 (0.94, 1.09)	0.87 (0.79, 0.97)	1.06 (0.85, 1.32)	0.91 (0.81, 1.02)	0.84 (0.74, 0.95)
Bachelor's degree	1.01 (0.91, 1.11)	0.87 (0.81, 0.94)	0.99 (0.89, 1.10)	1.16 (0.93, 1.46)	0.87 (0.77, 0.98)	0.84 (0.74, 0.95)
Postgraduate degree	0.91 (0.80, 1.04)	0.74 (0.67, 0.82)	0.96 (0.83, 1.11)	1.11 (0.82, 1.49)	0.71 (0.61, 0.83)	0.71 (0.61, 0.84)
Marital status						
Never married	1.00	1.00	1.00	1.00	1.00	1.00
Married	1.22 (1.16, 1.28)	1.11 (1.06, 1.16)	0.98 (0.93, 1.04)	1.26 (1.12, 1.41)	1.24 (1.17, 1.32)	0.92 (0.87, 0.98)
Divorce/separated/widowed	1.28 (1.16, 1.42)	1.13 (1.05, 1.22)	1.02 (0.92, 1.14)	1.38 (1.17, 1.62)	1.24 (1.14, 1.36)	1.04 (0.95, 1.14)
Race/ethnicity						
White/non-Hispanic	1.00	1.00	1.00	1.00	1.00	1.00
Black/non-Hispanic	1.19 (1.10, 1.28)	1.21 (1.14, 1.29)	0.98 (0.90, 1.06)	1.23 (1.07, 1.43)	1.12 (1.04, 1.21)	0.89 (0.83, 0.97)
Hispanic	1.15 (1.06, 1.24)	1.16 (1.08, 1.24)	1.31 (1.21, 1.42)	1.52 (1.29, 1.79)	1.22 (1.10, 1.34)	0.99 (0.89, 1.09)
Asian/Pacific Islander	1.14 (1.05, 1.24)	1.20 (1.11, 1.29)	1.10 (1.00, 1.21)	1.39 (1.15, 1.69)	1.17 (1.05, 1.31)	0.90 (0.80, 1.02)
American Indian	0.99 (0.83, 1.18)	1.20 (1.02, 1.40)	1.17 (0.97, 1.41)	0.99 (0.68, 1.43)	1.35 (1.12, 1.63)	0.95 (0.78, 1.17)
Other	1.19 (0.98, 1.45)	1.18 (1.00, 1.39)	1.25 (1.01, 1.54)	1.52 (1.00, 2.31)	1.08 (0.85, 1.36)	0.96 (0.74, 1.25)
Military rank						
Enlisted	1.00	1.00	1.00	1.00	1.00	1.00
Officer	1.02 (0.93, 1.11)	0.81 (0.76, 0.87)	0.83 (0.77, 0.93)	0.91 (0.75, 1.10)	0.83 (0.75, 0.92)	0.83 (0.74, 0.92)
Service component						
Reserve/National Guard	1.00	1.00	1.00	1.00	1.00	1.00
Active duty	0.97 (0.92, 1.02)	1.06 (1.01, 1.10)	1.17 (1.11, 1.24)	1.01 (0.89, 1.13)	1.01 (0.95, 1.07)	1.21 (1.13, 1.29)
Branch of service						
Army	1.00	1.00	1.00	1.00	1.00	1.00
Navy/Coast Guard	0.95 (0.89, 1.01)	0.99 (0.94, 1.04)	0.95 (0.88, 1.01)	0.98 (0.85, 1.14)	0.99 (0.92, 1.07)	0.99 (0.92, 1.07)
Air Force	1.09 (1.03, 1.15)	0.89 (0.85, 0.93)	0.82 (0.77, 0.87)	0.96 (0.85, 1.08)	1.04 (0.98, 1.11)	0.88 (0.82, 0.94)
Marine Corps	1.17 (1.09, 1.24)	1.22 (1.15, 1.30)	1.09 (1.01, 1.17)	0.99 (0.77, 1.27)	1.02 (0.89, 1.18)	1.35 (1.17, 1.56)

(*Continued*)

TABLE 3. (Continued)

	Men (n = 72,718)			Women (n = 33,980)		
	Bodybuilding* Odds ratio (95% CI)	Energy† Odds ratio (95% CI)	Weight loss Odds ratio (95% CI)	Bodybuilding Odds ratio (95% CI)	Energy Odds ratio (95% CI)	Weight-loss Odds ratio (95% CI)
Body mass index						
Underweight	1.00	1.00	1.00	1.00	1.00	1.00
Healthy weight	1.13 (0.82, 1.55)	1.11 (0.85, 1.45)	0.91 (0.54, 1.55)	0.48 (0.35, 0.67)	0.98 (0.81, 1.19)	3.55 (2.55, 4.96)
Overweight	0.86 (0.62, 1.18)	1.19 (0.92, 1.56)	4.87 (2.88, 8.26)	0.29 (0.20, 0.41)	0.82 (0.67, 0.99)	10.61 (7.60, 14.83)
Obese	0.62 (0.45, 0.86)	1.08 (0.83, 1.41)	11.90 (7.02, 20.19)	0.31 (0.23, 0.44)	0.65 (0.52, 0.80)	15.04 (10.70, 21.14)
Occupation						
Functional support	1.00	1.00	1.00	1.00	1.00	1.00
Combat specialist	1.19 (1.11, 1.28)	1.10 (1.03, 1.17)	0.82 (0.76, 0.89)	1.05 (0.83, 1.32)	1.11 (0.99, 1.25)	0.87 (0.76, 0.98)
Health care	1.20 (1.08, 1.32)	0.96 (0.88, 1.05)	1.02 (0.91, 1.13)	1.11 (0.95, 1.29)	1.00 (0.92, 1.08)	0.91 (0.84, 0.99)
Construction	0.95 (0.79, 1.15)	1.08 (0.93, 1.26)	0.76 (0.61, 0.93)	1.16 (0.61, 2.21)	0.99 (0.71, 1.38)	0.90 (0.63, 1.28)
Other	1.02 (0.96, 1.09)	1.09 (1.04, 1.15)	0.92 (0.86, 0.98)	1.26 (1.11, 1.42)	1.11 (1.04, 1.18)	0.91 (0.85, 0.97)
Problem drinker‖						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	1.21 (1.14, 1.28)	1.48 (1.40, 1.56)	1.10 (1.03, 1.17)	1.20 (1.03, 1.40)	1.70 (1.56, 1.86)	1.32 (1.21, 1.45)
Smoking status						
Nonsmoker	1.00	1.00	1.00	1.00	1.00	1.00
Past smoker	1.04 (0.98, 1.12)	1.09 (1.04, 1.15)	0.98 (0.91, 1.05)	1.02 (0.86, 1.21)	1.16 (1.06, 1.26)	1.08 (0.98, 1.18)
Current smoker	0.85 (0.81, 0.89)	1.32 (1.27, 1.38)	0.99 (0.94, 1.04)	0.85 (0.75, 0.96)	1.51 (1.42, 1.61)	1.13 (1.05, 1.20)
Depression						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	0.80 (0.70, 0.90)	0.97 (0.87, 1.07)	1.07 (0.95, 1.21)	0.87 (0.68, 1.10)	0.91 (0.80, 1.04)	1.21 (1.06, 1.38)
Eating disorder						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	0.96 (0.85, 1.08)	0.94 (0.86, 1.04)	1.82 (1.64, 2.02)	1.09 (0.86, 1.37)	1.09 (0.96, 1.24)	1.74 (1.53, 1.98)
Amount of sleep						
5 or less hours	0.88 (0.83, 0.94)	1.37 (1.30, 1.45)	1.28 (1.20, 1.37)	0.99 (0.86, 1.15)	1.29 (1.19, 1.39)	1.19 (1.10, 1.29)
6 hours	0.98 (0.93, 1.03)	1.28 (1.23, 1.33)	1.16 (1.10, 1.23)	0.98 (0.87, 1.12)	1.22 (1.15, 1.30)	1.13 (1.05, 1.21)
7–8 hours	1.00	1.00	1.00	1.00	1.00	1.00
⩾9 hours	1.06 (0.96, 1.18)	1.08 (0.99, 1.18)	1.15 (1.02, 1.29)	1.13 (0.94, 1.36)	1.06 (0.96, 1.17)	1.07 (0.97, 1.19)
Trouble sleeping						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	1.03 (0.97, 1.08)	1.19 (1.14, 1.24)	1.20 (1.14, 1.27)	0.99 (0.88, 1.13)	1.28 (1.21, 1.36)	1.27 (1.19, 1.35)
Panic or anxiety						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	0.98 (0.86, 1.11)	0.89 (0.81, 0.99)	0.84 (0.74, 0.95)	1.02 (0.82, 1.28)	1.14 (1.01, 1.29)	0.86 (0.76, 0.98)
PTSD symptoms						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	0.95 (0.86, 1.05)	1.01 (0.93, 1.11)	1.07 (0.96, 1.19)	1.21 (0.99, 1.49)	1.06 (0.95, 1.19)	0.87 (0.77, 0.98)
Panel#						
Panel 1	1.00	1.00	1.00	1.00	1.00	1.00
Panel 2	1.16 (1.08, 1.25)	1.09 (1.02, 1.16)	1.00 (0.92, 1.09)	1.08 (0.91, 1.27)	1.01 (0.93, 1.11)	0.94 (0.86, 1.03)
Panel 3	1.35 (1.25, 1.45)	1.06 (0.99, 1.13)	1.07 (0.98, 1.16)	0.95 (0.80, 1.12)	1.03 (0.94, 1.12)	0.94 (0.86, 1.04)

CI = confidence interval; PTSD = posttraumatic stress disorder.
*Bodybuilding supplements are defined as amino acids, weight gain products, and products like creatine.
†Energy supplements are defined as energy drinks, pills, or energy-enhancing herbs.
‡Deployment experience means having deployed in support of the operations in Iraq or Afghanistan any time from study enrollment to the 2007–08 survey cycle.
§Meets the standard from Healthy People 2010 of ⩾2 days/week of strength training activity.
¶Meets the standards from Healthy People 2010 of ⩾30 minutes/day on ⩾5 days/week of moderate/light activity, or ⩾20 minutes/day on ⩾3 days/week of vigorous activity.
‖Problem drinkers were defined as those who provided at least one affirmative answer to the 5-item Patient Health Questionnaire.
#Panel number indicates enrollment year into the Cohort. Panel 1 was enrolled from 2001 to 2003, panel 2 was enrolled from 2004 to 2006, and panel 3 was enrolled from 2007 to 2008.

we could not determine whether supplement use occurred during deployment or in proximity to deployment. Although the supplement question on the survey asked about three different types of supplements, other important supplement types such as multivitamins and fish oils were not assessed. Finally, this study was conducted with a cross-sectional sample; therefore, temporal associations could not be established. Future analyses of this cohort

will allow for prospective follow-up and the observation of temporal associations.

Our study had several strengths. To our knowledge, this study is the first to examine three different supplement types and characteristics associated with their use among a large military population. The population-based design allowed for assessment among all service branches and components (active duty, Reserve, and National Guard), including those no longer serving in the military. Although limitations exist with self-reported data, previous analyses have shown that Millennium Cohort participants self-report data reliably, well represent the U.S. military, and were not influenced to participate on the basis of previous health (53–60). Additional strengths of the study include the large sample size that provided statistical power and the ability to control for multiple confounders.

This study demonstrated that nearly half of the subjects in this large military cohort report use of either bodybuilding, weight-loss, or energy supplements, with deployment experience, physical activity, problem drinking, and suboptimal sleep emerging as important characteristics associated with supplement use. This study contributes to public health in several ways since this military population represents a group of relatively young, healthy individuals, and their use of the specific supplements studied here may be similar to young adults in the general population.

Currently, subgroups of military personnel more likely to use supplements are not well-defined. Some important associations revealed in this study such as deployment experience and bodybuilding, energy, and weight-loss supplement use are unique to a military population. This offers important information to military leadership that may seek to better understand the characteristics of these individuals to help focus educational messages regarding the safety of various types of supplements, or help promote their use in cases where such use may be beneficial to one's health. In addition, follow-up studies to evaluate adverse health events related to supplement use are planned. Identifying populations with greater likelihood for bodybuilding, energy, and weight-loss supplement use, such as deployers as identified in this study, may be of importance to medical planners and military policy makers in targeting adverse event monitoring and determining how supplements affect performance and health over time.

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