

Prevalence of and Factors Associated with Dietary Supplement Use in a Stratified, Random Sample of US Military Personnel: The US Military Dietary Supplement Use Study

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ABSTRACT

Background: About 50% of Americans and 70% of US military service members use dietary supplements (DSs).

Objectives: This cross-sectional survey examined current prevalence of and factors associated with DS use in service members.

Methods: A stratified random sample of 200,000 service members from the Air Force, Army, Marine Corps, and Navy was obtained from military manpower records, and these service members were asked to complete a questionnaire on their DS use and personal characteristics. Chi-square statistics and multivariable logistic regression examined differences across various strata of demographic, lifestyle, and military characteristics.

Results: About 18% of successfully contacted service members ($n = 26,681$) completed the questionnaire between December 2018 and August 2019 (mean \pm SD age: 33 ± 8 y, 86% male). Overall, 74% reported using ≥ 1 DS/wk. Multivitamins/multiminerals were the most commonly used DSs (45%), followed by combination products (44%), proteins/amino acids (42%), individual vitamins/minerals (31%), herbals (20%), joint health products (9%), and purported prohormones (5%). In multivariable analysis, factors independently associated with DS use included female gender [OR (female/male): 1.91; 95% CI: 1.73, 2.11], older age [$\geq 40/18-24$ y): 1.25; 95% CI: 1.08, 1.44], higher education level [OR (college degree/high school or less): 1.35; 95% CI: 1.19, 1.53], higher BMI [OR ($\geq 30/<25$ kg/m²): 1.37; 95% CI: 1.25, 1.52], more weekly resistance training [OR ($>300/\leq 45$ min/wk): 5.05; 95% CI: 4.55, 5.61], smokeless tobacco use [OR (user/nonuser): 1.30; 95% CI: 1.17, 1.44], higher alcohol intake [OR ($\geq 72/0$ mL/wk): 1.41; 95% CI: 1.29, 1.54], and higher military rank [OR (senior officer/junior enlisted): 1.26; 95% CI: 1.06, 1.51].

Conclusions: Compared with civilian data from the NHANES, service members were much more likely to use DSs and used different types of DSs, especially combination products and proteins/amino acids often used to purportedly enhance physical performance. Comparisons with previous military data suggest DS use has increased over time. *J Nutr* 2021;151:3495–3506.

Keywords: multivitamin/multimineral, vitamin, mineral, prohormone, combination products, herbals, joint health products

Introduction

Dietary supplements (DSs) are commercially-available products consumed as an addition to the usual diet and include vitamins, minerals, herbs (botanicals), amino acids (AAs), and a variety of other products (1). Marketing claims for some DSs include improvements in overall health status, enhancement of cognitive or physical performance, increases in energy, loss of excess weight, attenuation of pain, and other favorable effects. Past studies indicate ~50% of the US population (2, 3) and ~70% of US

military personnel use DSs (4–6). The types of DSs used by military personnel are considerably different than those used by civilians. For example, ~33% of service members use protein/AA compounds (4, 6) compared with only 4% of civilians (7).

The Dietary Supplement Health and Education Act of 1994 (DSHEA) (1) established the regulatory structure for DSs in the United States. Since the DSHEA became law, US sales of DSs have increased from \$4 billion in 1994 to \$46 billion in 2018 (8, 9), a 12-fold increase over 25 y. Vitamin sales alone were \$14

billion and sales of herbal substances exceeded \$8 billion (9, 10). Under the DSHEA, the FDA has limited authority to regulate DSs. Manufacturers must notify the FDA 75 d before marketing a new DS, and although the FDA can review marketing claims, FDA approval is not required for retailing a DS product.

Because early studies (11–14) in selected military populations suggested a high use of DSs in the military, an Institute of Medicine report (15) recommended representative, comprehensive, and ongoing surveys of all military personnel to monitor the prevalence of DS use and to examine subgroups that might have higher DS use. Over a period of 9 y, from 2006 to 2014, our research team completed separate surveys of Army (16), Air Force (6), Navy/Marine Corps (4), and Coast Guard (17) personnel. These surveys used a similar questionnaire, but they were customized for the population surveyed and updated for DSs currently available to service members on military installations or in the local community (18). Most of these surveys (6, 16, 17) involved convenience samples. From 2006 to 2011, DS use appears to have increased among Army personnel (19), but it is not known if this trend has continued or is apparent in the other military services. The study reported here involves a comprehensive examination of current DS use in a stratified random sample of all military services using the same survey instrument and explores the current prevalence of and factors associated with DS use.

Methods

This investigation involved a cross-sectional survey completed by a stratified, random sample of US active duty military service members. The Naval Health Research Center (NHRC) Institutional Review Board approved the investigation and participants signed an informed consent document. Investigators adhered to policies and procedures for protection of human subjects as prescribed by Department of Defense Instruction 3216.01, and the research was conducted in adherence to provisions of 32 Code of Federal Regulations, Part 219.

Sampling frame

The Defense Manpower Data Center (DMDC) provided a list of a random sample of 200,000 service members currently on active duty

with ≥ 6 mo of service and ≥ 1 y of estimated time before expected separation from service as of June 2018. The sample was stratified by sex (88% male and 12% female) and branch of service (Army 36%, Air Force 24%, Marine Corps 15%, and Navy 25%) based on military demographics in 2018. Data requested and obtained from the DMDC included the service member's name, identification number, service branch, sex, pay grade (rank), date of birth, marital status, race/ethnicity, education level, military occupational specialty code, postal address, and email address. The National Change of Address file provided by the US Postal Service was referenced to ensure the most up-to-date postal address was used.

The size of the sampling frame was determined based on subpopulation response rates of previous NHRC questionnaire investigations, a pilot study (4), and statistical power considerations. Previous investigations by the NHRC indicated that $\sim 75\%$ of service members would be successfully contacted and $\sim 20\%$ of service members would volunteer for the study. It was estimated that if use prevalence of a particular DS category was 20%, α error was set at ≤ 0.05 , and β error at < 0.20 (power ≥ 0.80), this would detect a difference in prevalence of 1.2 between various demographic, lifestyle, and military strata, and a sample of ~ 5600 service members in each stratum would be needed. Thus, a comparison involving 5 equally sized strata would require 28,000 responders.

Solicitation procedures

Potential participants were contacted a maximum of 12 times. The first contact was an introductory postal letter including information about the purpose of the study, the investigators and their command affiliations, the sponsors, and the reason for conducting the study. The introductory letter provided the service member with a preincentive of \$1 to increase the response rate (20, 21). The letter described the survey, included a link to a secure website, and provided a unique login used to access the survey and electronically sign the consent form. The subsequent contacts included ≤ 7 emails and ≤ 3 postcard reminders evenly distributed across the time the survey was open. Responders were taken off the distribution list, so the reminders were sent only to those who did not respond. The survey closed after 9 mo and responders were sent a “thank you” postcard for participating. All postal and email contacts stated that at any time the service member could decline participation and would be removed from the contact list. Recruitment began in December 2018, and no further recruitment was conducted nor surveys accepted after August 2019.

Survey description

The survey was similar to previous instruments (18) and designed to comprehensively describe participants and obtain types of DSs used and frequency of their use. To describe participants, there were questions on demographics (e.g., sex, age, education level, marital status, height, weight), lifestyle (amount of exercise, tobacco use, alcohol consumption), and military characteristics (rank, occupational assignment, service branch). Supplement use questions included 96 generic DSs [e.g., multivitamins/multiminerals (MVMs), individual vitamins and minerals, proteins/AAs, herbals, joint health products] and 62 brand name products. The brand name products included some of those used in previous armed forces studies (4, 16, 17), but some were updated based on a review of DS inventories in the Army, Navy, and Air Force Exchange Services and General Nutrition Center stores on or near military installations. There were also open-text fields on the questionnaire where service members could include supplements not on the provided lists. Service members were asked to estimate how frequently each supplement was used during the past 6 mo (“never,” “once a month,” “once a week,” “2–6 times/week,” or “daily”). Service members were also asked to estimate how much money they spent on supplements monthly. Table 1 provides the DS category definitions used in this study.

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Supplemental Table 1 is available from the “Supplementary data” link in the online posting of the article and from the same link in the online table of contents at <https://academic.oup.com/jn>.

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Abbreviations used: AA, amino acid; AE, adverse effect; DMAA, 1,3-dimethylamylamine; DMDC, Defense Manpower Data Center; DS, dietary supplement; DSHEA, Dietary Supplement Health and Education Act of 1994; MVM, multivitamin/multimineral; NHRC, Naval Health Research Center.

TABLE 1 DS categories in study of US service members¹

Category	Definition
DS	Any substance defined by the DSHEA.
Multivitamin/Multimineral	DS containing ≥ 2 vitamins and/or ≥ 2 minerals with no additional supplement ingredients.
Protein or AA	AA mixtures, protein powders, and similar products where the intent is to provide a single AA or complex protein source.
Individual Vitamin or Mineral	DS that is a single vitamin or mineral supplement, such as vitamin D or calcium.
Herbal	DS that includes ≥ 1 herbal ingredients with no nutrient or other supplement ingredient. Includes plant-derived ingredients.
Purported Prohormone	Steroidal hormone or herbal substitute for hormones marketed as a DS and included on the Nutrition and Supplement Facts label.
Combination Product	DS with mixtures of ingredients from any of the above categories, including ≥ 2 categories and multiple ingredients.
Joint Health Product	Includes products marketed as weight loss, pre- or postworkout supplements, and muscle/body-building products. Substance that purports to improve the functioning of body joints, such as glucosamine (with or without chondroitin) or methylsulfonylmethane.
Other DS	Other DS that does not fit into the categories above.

¹AA, amino acid; DS, dietary supplement; DSHEA, Dietary Supplement Health and Education Act of 1994 (1).

Data analyses

All statistical analyses were conducted using IBM SPSS Statistics version 26 (IBM). BMI was computed from the questionnaire responses as weight/height² (in kg/m²). Weekly duration of aerobic and resistance training (min/wk) was calculated by multiplying reported weekly exercise frequency (sessions/wk) by reported duration of training (min/session). Alcohol consumption was quantified using the NIH assumption that a “standard drink” contained 17.74 mL alcohol (22). Standard drinks included 12 ounces (355 ml) of regular beer or fermented fruit drink (5% alcohol), 8.5 ounces (251 ml) of higher-alcohol beer (7% alcohol), 5 ounces (148 ml) of wine (12% alcohol), 4.25 ounces (125 ml) of fortified wine (15% alcohol), and 1.5 ounces (44 ml) of liquor (40% alcohol). Supplements that service members placed in the “other” categories were examined, and responses were placed into their proper DS category or listed as “other” supplements if they did not fit a defined DS category (Table 1).

Prevalence (%) \pm SE was calculated for each DS. Chi-square statistics were used to examine differences across various strata of demographic, lifestyle, and military characteristics. Where variables were ordinal (i.e., age, education level, BMI, aerobic training duration, resistance training duration, and alcohol intake), chi-square tests for linear trend (Mantel–Haenszel statistic) were also performed. Multivariable logistic regression was used to examine associations between independent variables involving demographic, lifestyle, and military characteristics and dependent variables that included the DS categories. All demographic, lifestyle, and military characteristics were included (controlled for) in the models. Because some participants did

not complete all questions, the number of service members is shown for each variable.

To address response bias, chi-square analyses compared responders and nonresponders by sex, education level, rank, and military service. *t* Tests were used to assess differences in age and time in service.

Results

Figure 1 presents subject flow during the investigation. From the initial sample frame of 200,000 service members, 73% ($n = 146,365$) were successfully contacted (i.e., there was no returned postal mail) and, of these, 26,681 (18.2%) signed the informed consent and completed the questionnaire.

The mean \pm SD age, height, weight, and BMI of male responders was 32.8 ± 8.1 y, 178.3 ± 7.5 cm, 85.9 ± 12.6 kg, and 27.0 ± 3.4 , respectively. These values for female responders were 32.0 ± 8.2 y, 164.6 ± 7.5 cm, 69.2 ± 11.7 kg, and 25.5 ± 3.8 , respectively.

Overall prevalence and types of DSs used

Table 2 provides prevalence, number, and types of DSs consumed by service members in the past 6 mo. Seventy-four percent of service members reported using ≥ 1 DSs ≥ 1 times/wk. In descending order, the most commonly consumed DSs by category were MVMs, combination products, proteins/AAs, individual vitamins/minerals, other DSs, herbals, joint health

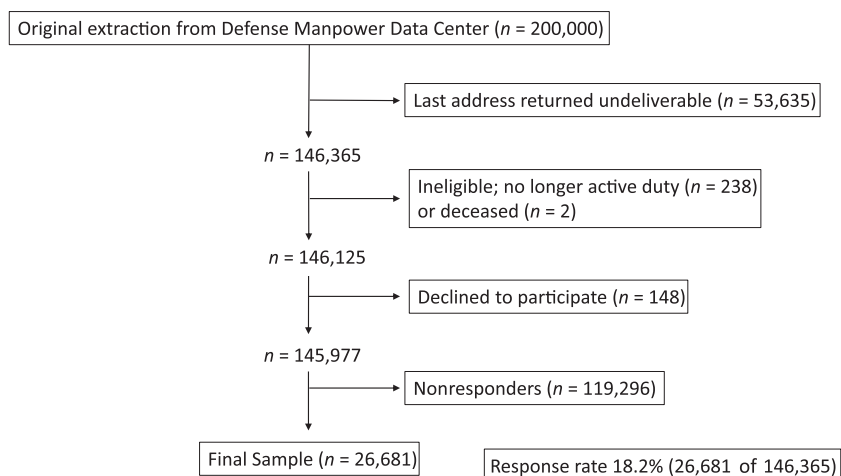


FIGURE 1 Flowchart summarizing service member recruitment, loss, and final responders.

TABLE 2 Prevalence of DS use by demographic, lifestyle, and military characteristics of US service members, based on self-report for the past 6 mo at the time of survey¹

Variable	Stratum	Number of DSs taken ≥ 1 time/wk (% \pm SE)					DSs taken ≥ 1 time/wk (% \pm SE)					Other DS	
		Any DS taken ≥ 1 time/wk (% \pm SE)	1–2	3–4	≥ 5	Multivitamin /Multimineral	Individual Vitamin or Mineral	Protein or Amino Acid	Combination Product	Purported Prohormone	Herbal		Joint Health Product
Group	All (n = 26,681)	74.0 \pm 0.3	19.9 \pm 0.2	14.0 \pm 0.2	4.01 \pm 0.3	44.5 \pm 0.3	30.8 \pm 0.3	42.2 \pm 0.3	44.4 \pm 0.3	4.9 \pm 0.1	20.2 \pm 0.2	9.4 \pm 0.2	30.6 \pm 0.3
	Men (n = 23,038)	73.2 \pm 0.3	19.6 \pm 0.3	13.6 \pm 0.2	4.00 \pm 0.3	43.1 \pm 0.3	28.7 \pm 0.3	43.8 \pm 0.3	45.3 \pm 0.3	5.5 \pm 0.2	18.5 \pm 0.3	9.2 \pm 0.2	30.4 \pm 0.3
	Women (n = 3,642)	79.0 \pm 0.7	21.4 \pm 0.7	16.9 \pm 0.6	4.07 \pm 0.5	53.8 \pm 0.8	44.6 \pm 0.8	<0.01	32.0 \pm 0.8	38.4 \pm 0.8	0.8 \pm 0.1	30.4 \pm 0.8	11.1 \pm 0.5
Age, y	P value (chi-square)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.03
	18–24 (n = 4,660)	68.4 \pm 0.7	18.0 \pm 0.6	11.7 \pm 0.5	3.88 \pm 0.7	33.8 \pm 0.6	25.8 \pm 0.6	45.2 \pm 0.7	46.4 \pm 0.7	3.8 \pm 0.3	16.0 \pm 0.5	3.7 \pm 0.3	26.1 \pm 0.6
	25–29 (n = 5,580)	75.6 \pm 0.6	17.7 \pm 0.5	14.5 \pm 0.5	4.34 \pm 0.7	47.1 \pm 0.7	29.3 \pm 0.6	49.8 \pm 0.7	48.7 \pm 0.7	4.2 \pm 0.3	20.2 \pm 0.5	7.6 \pm 0.4	31.5 \pm 0.6
	30–39 (n = 11,031)	75.7 \pm 0.4	20.6 \pm 0.4	14.2 \pm 0.3	4.03 \pm 0.5	47.8 \pm 0.5	31.3 \pm 0.4	43.0 \pm 0.5	45.6 \pm 0.5	5.2 \pm 0.2	20.8 \pm 0.4	11.0 \pm 0.4	31.0 \pm 0.4
	≥ 40 (n = 5,275)	73.7 \pm 0.6	22.2 \pm 0.6	15.1 \pm 0.5	3.63 \pm 0.7	48.4 \pm 0.7	35.9 \pm 0.7	30.9 \pm 0.6	36.2 \pm 0.7	5.9 \pm 0.3	22.3 \pm 0.6	13.0 \pm 0.5	33.0 \pm 0.6
Education level	P value (chi-square/trend)	<0.01/<0.01	<0.01	<0.01	<0.01	<0.01/<0.01	<0.01/<0.01	<0.01/<0.01	<0.01/<0.01	<0.01/<0.01	<0.01/<0.01	<0.01/<0.01	<0.01/<0.01
	Some HS/HS grad (n = 3879)	66.2 \pm 0.8	18.5 \pm 0.6	10.6 \pm 0.5	3.70 \pm 0.8	32.3 \pm 0.8	23.5 \pm 0.7	41.3 \pm 0.8	45.6 \pm 0.8	5.0 \pm 0.5	14.9 \pm 0.6	4.8 \pm 0.3	24.3 \pm 0.7
	Some college (n = 11,378)	75.0 \pm 0.4	18.7 \pm 0.4	13.6 \pm 0.3	4.27 \pm 0.5	44.5 \pm 0.5	31.2 \pm 0.4	44.3 \pm 0.5	48.5 \pm 0.5	5.4 \pm 0.2	21.2 \pm 0.4	9.0 \pm 0.3	31.4 \pm 0.4
Marital status	College degree (n = 11,418)	75.6 \pm 0.4	21.6 \pm 0.4	15.6 \pm 0.3	3.85 \pm 0.5	48.8 \pm 0.5	32.9 \pm 0.4	40.5 \pm 0.5	39.9 \pm 0.4	4.3 \pm 0.2	20.9 \pm 0.4	11.3 \pm 0.3	32.0 \pm 0.4
	P value (chi-square/trend)	<0.01/<0.01	<0.01	<0.01	<0.01	<0.01/<0.01	<0.01/<0.01	<0.01/0.12	<0.01/0.15	<0.01/0.20	<0.01/<0.01	<0.01/<0.01	<0.01/<0.01
	Never married (n = 6,471)	71.8 \pm 0.6	18.0 \pm 0.5	12.9 \pm 0.4	4.09 \pm 0.6	40.1 \pm 0.6	29.1 \pm 0.6	45.7 \pm 0.6	46.1 \pm 0.6	4.0 \pm 0.2	18.7 \pm 0.5	6.7 \pm 0.3	29.8 \pm 0.6
	Married (n = 17,666)	74.2 \pm 0.3	20.9 \pm 0.3	14.5 \pm 0.3	3.88 \pm 0.4	45.8 \pm 0.4	30.6 \pm 0.3	40.5 \pm 0.4	43.2 \pm 0.4	4.8 \pm 0.2	20.2 \pm 0.3	9.9 \pm 0.2	30.3 \pm 0.4
	Sep. wid. div (n = 2,145)	79.0 \pm 0.9	16.7 \pm 0.8	13.2 \pm 0.7	4.91 \pm 1.1	48.2 \pm 1.1	38.4 \pm 1.1	47.3 \pm 1.1	50.5 \pm 1.1	8.1 \pm 0.6	24.8 \pm 0.9	13.6 \pm 0.7	36.7 \pm 1.0
BMI, kg/m ²	P value (chi-square)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	<25.0 (n = 7,856)	70.0 \pm 0.5	21.6 \pm 0.5	14.2 \pm 0.4	3.43 \pm 0.5	40.4 \pm 0.6	29.7 \pm 0.5	38.0 \pm 0.5	36.5 \pm 0.5	2.6 \pm 0.2	19.6 \pm 0.4	7.2 \pm 0.3	26.6 \pm 0.5
	25–29 (n = 13,898)	75.2 \pm 0.4	19.3 \pm 0.3	14.2 \pm 0.3	4.17 \pm 0.4	45.8 \pm 0.4	30.5 \pm 0.4	44.3 \pm 0.4	46.4 \pm 0.4	5.3 \pm 0.2	20.0 \pm 0.3	10.1 \pm 0.3	31.9 \pm 0.4
	≥ 30.0 (n = 4,424)	78.0 \pm 0.6	18.9 \pm 0.6	13.3 \pm 0.5	4.58 \pm 0.7	48.8 \pm 0.8	34.0 \pm 0.7	43.6 \pm 0.7	52.6 \pm 0.8	7.6 \pm 0.4	22.0 \pm 0.6	11.2 \pm 0.5	34.4 \pm 0.7
	P value (chi-square/trend)	<0.01/0.01	<0.01	<0.01	<0.01	<0.01/<0.01	<0.01/<0.01	<0.01/<0.01	<0.01/<0.01	<0.01/<0.01	<0.01/<0.01	<0.01/<0.01	<0.01/<0.01
Aerobic exercise duration, min/wk	0–90 (n = 7,287)	71.7 \pm 0.5	20.0 \pm 0.5	13.8 \pm 0.4	3.79 \pm 0.6	42.1 \pm 0.6	28.7 \pm 0.5	40.1 \pm 0.6	41.9 \pm 0.6	4.1 \pm 0.2	18.3 \pm 0.5	8.0 \pm 0.3	28.8 \pm 0.5
	91–180 (n = 7,285)	71.7 \pm 0.5	22.7 \pm 0.5	14.8 \pm 0.4	3.42 \pm 0.6	43.0 \pm 0.6	28.5 \pm 0.5	37.2 \pm 0.6	39.0 \pm 0.6	3.9 \pm 0.2	18.5 \pm 0.5	8.5 \pm 0.3	27.8 \pm 0.5
	181–300 (n = 5,869)	75.1 \pm 0.6	20.1 \pm 0.5	14.3 \pm 0.5	4.07 \pm 0.6	45.6 \pm 0.7	31.1 \pm 0.6	42.5 \pm 0.6	45.4 \pm 0.7	5.0 \pm 0.3	21.0 \pm 0.5	10.5 \pm 0.4	31.5 \pm 0.6
	>300 (n = 6,240)	78.2 \pm 0.5	16.2 \pm 0.5	13.1 \pm 0.4	4.89 \pm 0.6	48.1 \pm 0.6	35.8 \pm 0.6	50.3 \pm 0.6	52.8 \pm 0.6	6.8 \pm 0.3	23.5 \pm 0.5	11.0 \pm 0.4	35.3 \pm 0.6
	P value (chi-square/trend)	<0.01/<0.01	<0.01	<0.01	<0.01	<0.01/<0.01	<0.01/<0.01	<0.01/<0.1	<0.01/<0.01	<0.01/<0.01	<0.01/<0.01	<0.01/<0.01	<0.01/<0.01
Resistance training duration, min/wk	≤ 45 (n = 7,776)	62.3 \pm 0.6	26.2 \pm 0.5	14.0 \pm 0.4	2.21 \pm 0.5	37.6 \pm 0.5	26.4 \pm 0.5	18.5 \pm 0.4	28.8 \pm 0.5	2.0 \pm 0.2	16.1 \pm 0.4	5.9 \pm 0.3	21.0 \pm 0.5
	46–135 (n = 6,257)	70.0 \pm 0.6	23.7 \pm 0.5	15.9 \pm 0.5	3.04 \pm 0.6	42.0 \pm 0.6	28.5 \pm 0.6	32.4 \pm 0.6	34.2 \pm 0.6	2.8 \pm 0.2	19.4 \pm 0.5	7.9 \pm 0.3	26.6 \pm 0.6
	136–300 (n = 6,582)	80.2 \pm 0.5	17.2 \pm 0.5	15.2 \pm 0.4	4.79 \pm 0.6	47.5 \pm 0.6	31.9 \pm 0.6	54.4 \pm 0.6	52.8 \pm 0.6	5.3 \pm 0.3	21.2 \pm 0.5	11.3 \pm 0.4	34.4 \pm 0.6
	>300 (n = 6,066)	86.2 \pm 0.4	10.6 \pm 0.4	10.9 \pm 0.4	6.46 \pm 0.6	52.9 \pm 0.6	37.8 \pm 0.6	69.5 \pm 0.6	68.3 \pm 0.6	10.3 \pm 0.4	25.0 \pm 0.6	13.5 \pm 0.4	43.0 \pm 0.6
	P value (chi-square/trend)	<0.01/<0.01	<0.01	<0.01	<0.01	<0.01/<0.01	<0.01/<0.01	<0.01/<0.01	<0.01/<0.01	<0.01/<0.01	<0.01/<0.01	<0.01/<0.01	<0.01/<0.01
Smoking	Never smoked (n = 16,706)	73.0 \pm 0.3	20.2 \pm 0.3	14.1 \pm 0.3	3.86 \pm 0.4	45.1 \pm 0.4	31.2 \pm 0.4	40.9 \pm 0.4	41.4 \pm 0.4	4.2 \pm 0.2	20.2 \pm 0.3	9.6 \pm 0.2	30.3 \pm 0.4
	Smoked but quit (n = 4,767)	77.3 \pm 0.6	19.1 \pm 0.6	14.5 \pm 0.5	4.37 \pm 0.7	46.3 \pm 0.7	31.6 \pm 0.7	45.3 \pm 0.7	48.9 \pm 0.7	5.8 \pm 0.3	20.7 \pm 0.6	10.5 \pm 0.4	33.6 \pm 0.7
	Smoker (n = 4,512)	75.2 \pm 0.6	19.8 \pm 0.6	13.5 \pm 0.5	4.19 \pm 0.7	41.6 \pm 0.7	29.1 \pm 0.7	44.4 \pm 0.7	51.1 \pm 0.7	6.3 \pm 0.4	20.1 \pm 0.6	8.4 \pm 0.4	30.1 \pm 0.7
	P value (chi-square)	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	0.72	<0.01	<0.01
	Never used (n = 20,379)	72.8 \pm 0.3	20.4 \pm 0.3	14.2 \pm 0.2	3.81 \pm 0.3	44.4 \pm 0.3	31.0 \pm 0.3	40.2 \pm 0.3	41.6 \pm 0.3	4.2 \pm 0.1	20.2 \pm 0.3	9.2 \pm 0.2	29.8 \pm 0.3
Smokeless tobacco use	Used but quit (n = 2,047)	79.5 \pm 0.9	19.1 \pm 0.9	15.2 \pm 0.8	4.52 \pm 1.1	45.6 \pm 1.1	30.9 \pm 1.0	48.5 \pm 1.1	52.8 \pm 1.1	6.5 \pm 0.5	21.4 \pm 0.9	10.9 \pm 0.7	33.9 \pm 1.0
	User (n = 3,114)	79.2 \pm 0.7	17.6 \pm 0.7	12.7 \pm 0.6	4.90 \pm 0.9	45.3 \pm 0.9	29.4 \pm 0.8	52.6 \pm 0.9	57.5 \pm 0.9	8.3 \pm 0.5	19.7 \pm 0.7	10.6 \pm 0.6	35.7 \pm 0.9
	P value (chi-square)	<0.01	<0.01	<0.01	<0.01	0.43	0.17	<0.01	<0.01	<0.01	0.32	0.01	<0.01
	0 (n = 8,372)	69.4 \pm 0.5	19.3 \pm 0.4	12.8 \pm 0.4	3.73 \pm 0.5	41.7 \pm 0.5	30.8 \pm 0.5	38.5 \pm 0.5	38.8 \pm 0.5	4.3 \pm 0.2	17.8 \pm 0.4	7.4 \pm 0.3	27.1 \pm 0.5
	0.2–24.9 (n = 6,132)	74.0 \pm 0.5	21.4 \pm 0.5	14.0 \pm 0.4	3.86 \pm 0.6	44.9 \pm 0.6	31.7 \pm 0.6	39.7 \pm 0.6	42.9 \pm 0.6	4.1 \pm 0.2	21.1 \pm 0.5	9.9 \pm 0.4	30.7 \pm 0.6
Alcohol intake, ml/wk	25.0–71.7 (n = 6,108)	76.9 \pm 0.5	19.4 \pm 0.5	15.0 \pm 0.5	4.25 \pm 0.6	46.7 \pm 0.6	31.2 \pm 0.6	46.0 \pm 0.6	47.9 \pm 0.6	5.1 \pm 0.3	20.9 \pm 0.5	10.3 \pm 0.4	32.5 \pm 0.6
	>71.7 (n = 6,068)	77.2 \pm 0.5	19.6 \pm 0.5	14.7 \pm 0.5	4.30 \pm 0.6	45.9 \pm 0.6	30.0 \pm 0.6	46.8 \pm 0.6	48.8 \pm 0.6	6.2 \pm 0.3	21.7 \pm 0.5	10.9 \pm 0.4	33.5 \pm 0.6
	P value (chi-square/trend)	<0.01/<0.01	<0.01	<0.01	<0.01	<0.01/<0.01	0.20/0.57	<0.01/<0.01	<0.01/<0.01	<0.01/<0.01	<0.01/<0.01	<0.01/<0.01	<0.01/<0.01

(Continued)

TABLE 2 (Continued)

Variable	Stratum	Any DS taken ≥ 1 time/wk (% \pm SE)					Number of DSs taken ≥ 1 time/wk (% \pm SE)					DSs taken ≥ 1 time/wk (% \pm SE)											
		1-2	3-4	≥ 5	Multivitamin /Multimineral	Individual Vitamin or Mineral	Protein or Amino Acid	Combination Product	Purported Prohormone	Herbal	Joint Health Product	Other DS	1-2	3-4	≥ 5	Multivitamin /Multimineral	Individual Vitamin or Mineral	Protein or Amino Acid	Combination Product	Purported Prohormone	Herbal	Joint Health Product	Other DS
Rank ³	Junior enlisted (n = 2496)	66.4 \pm 0.9	18.7 \pm 0.8	11.9 \pm 0.6	35.8 \pm 1.0	32.9 \pm 0.9	35.8 \pm 1.0	32.9 \pm 0.9	32.9 \pm 0.9	32.9 \pm 0.9	32.9 \pm 0.9	27.6 \pm 0.9	48.8 \pm 1.0	43.2 \pm 1.0	3.1 \pm 0.3	43.2 \pm 1.0	48.8 \pm 1.0	48.8 \pm 1.0	48.8 \pm 1.0	48.8 \pm 1.0	43.2 \pm 1.0	3.1 \pm 0.3	16.3 \pm 0.7
	Mid-enlisted (n = 11,609)	73.6 \pm 0.4	18.0 \pm 0.4	12.9 \pm 0.3	42.9 \pm 0.5	42.9 \pm 0.5	42.9 \pm 0.5	42.9 \pm 0.5	42.9 \pm 0.5	42.9 \pm 0.5	42.9 \pm 0.5	30.2 \pm 0.4	44.6 \pm 0.5	48.6 \pm 0.5	5.4 \pm 0.2	48.6 \pm 0.5	44.6 \pm 0.5	44.6 \pm 0.5	44.6 \pm 0.5	48.6 \pm 0.5	5.4 \pm 0.2	19.9 \pm 0.4	
	Senior enlisted (n = 4,365)	76.7 \pm 0.6	21.1 \pm 0.6	14.8 \pm 0.5	40.8 \pm 0.7	40.8 \pm 0.7	40.8 \pm 0.7	40.8 \pm 0.7	40.8 \pm 0.7	40.8 \pm 0.7	40.8 \pm 0.7	32.9 \pm 0.7	40.3 \pm 0.7	45.9 \pm 0.8	7.0 \pm 0.4	45.9 \pm 0.8	40.3 \pm 0.7	40.3 \pm 0.7	40.3 \pm 0.7	45.9 \pm 0.8	7.0 \pm 0.4	20.9 \pm 0.6	
	Warrant officer (n = 576)	74.1 \pm 1.8	17.4 \pm 1.6	14.2 \pm 1.5	42.5 \pm 2.1	47.6 \pm 2.8	47.6 \pm 2.1	47.6 \pm 2.1	47.6 \pm 2.1	47.6 \pm 2.1	47.6 \pm 2.1	30.2 \pm 1.9	41.3 \pm 2.1	46.2 \pm 2.1	8.0 \pm 1.1	46.2 \pm 2.1	41.3 \pm 2.1	41.3 \pm 2.1	41.3 \pm 2.1	46.2 \pm 2.1	8.0 \pm 1.1	20.5 \pm 1.7	
	Junior officer (n = 3,882)	77.1 \pm 0.7	21.5 \pm 0.7	39.7 \pm 0.8	39.7 \pm 0.8	47.0 \pm 0.8	39.7 \pm 0.8	39.7 \pm 0.8	47.0 \pm 0.8	47.0 \pm 0.8	47.0 \pm 0.8	29.2 \pm 0.7	48.0 \pm 0.8	43.2 \pm 0.8	3.2 \pm 0.3	43.2 \pm 0.8	48.0 \pm 0.8	48.0 \pm 0.8	48.0 \pm 0.8	43.2 \pm 0.8	3.2 \pm 0.3	21.5 \pm 0.7	
Senior officer (n = 3,742)	73.6 \pm 0.7	23.9 \pm 0.7	15.8 \pm 0.6	33.9 \pm 0.8	50.2 \pm 0.8	33.9 \pm 0.8	33.9 \pm 0.8	50.2 \pm 0.8	50.2 \pm 0.8	50.2 \pm 0.8	34.3 \pm 0.8	32.1 \pm 0.8	31.3 \pm 0.8	3.3 \pm 0.3	31.3 \pm 0.8	32.1 \pm 0.8	32.1 \pm 0.8	32.1 \pm 0.8	31.3 \pm 0.8	3.3 \pm 0.3	21.1 \pm 0.7		
	P value (chi-square)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
Military occupational specialty	CA (n = 6,451)	75.8 \pm 0.5	19.3 \pm 0.5	14.1 \pm 0.4	42.4 \pm 0.6	45.2 \pm 0.6	42.4 \pm 0.6	42.4 \pm 0.6	45.2 \pm 0.6	45.2 \pm 0.6	47.0 \pm 0.6	47.4 \pm 0.6	5.7 \pm 0.3	20.1 \pm 0.5	11.0 \pm 0.4	20.1 \pm 0.5	5.7 \pm 0.3	5.7 \pm 0.3	5.7 \pm 0.3	20.1 \pm 0.5	11.0 \pm 0.4	32.1 \pm 0.6	
	CS (n = 10,424)	73.5 \pm 0.4	19.0 \pm 0.4	13.9 \pm 0.3	40.7 \pm 0.5	44.4 \pm 0.5	40.7 \pm 0.5	40.7 \pm 0.5	44.4 \pm 0.5	44.4 \pm 0.5	43.5 \pm 0.5	45.0 \pm 0.5	4.9 \pm 0.2	19.6 \pm 0.4	9.2 \pm 0.3	19.6 \pm 0.4	4.9 \pm 0.2	4.9 \pm 0.2	4.9 \pm 0.2	19.6 \pm 0.4	9.2 \pm 0.3	30.6 \pm 0.5	
	CSS (n = 9,133)	73.5 \pm 0.5	21.1 \pm 0.4	14.1 \pm 0.4	38.3 \pm 0.5	44.5 \pm 0.5	38.3 \pm 0.5	38.3 \pm 0.5	44.5 \pm 0.5	44.5 \pm 0.5	38.1 \pm 0.5	42.0 \pm 0.5	4.3 \pm 0.2	21.0 \pm 0.4	8.7 \pm 0.3	21.0 \pm 0.4	4.3 \pm 0.2	4.3 \pm 0.2	4.3 \pm 0.2	21.0 \pm 0.4	8.7 \pm 0.3	30.1 \pm 0.5	
	P value (chi-square)	<0.01	<0.01	<0.01	<0.01	0.54	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.04	<0.01	0.04	<0.01	<0.01	<0.01	0.04	<0.01	0.03	
Service branch	Air Force (n = 9789)	73.0 \pm 0.4	20.8 \pm 0.4	14.9 \pm 0.4	37.2 \pm 0.5	44.9 \pm 0.5	14.9 \pm 0.4	44.9 \pm 0.5	44.9 \pm 0.5	40.7 \pm 0.5	41.3 \pm 0.5	41.3 \pm 0.5	3.2 \pm 0.2	18.4 \pm 0.4	8.6 \pm 0.3	18.4 \pm 0.4	3.2 \pm 0.2	3.2 \pm 0.2	3.2 \pm 0.2	18.4 \pm 0.4	8.6 \pm 0.3	29.2 \pm 0.5	
	Army (n = 7,935)	75.6 \pm 0.5	18.9 \pm 0.4	13.5 \pm 0.4	43.1 \pm 0.6	45.6 \pm 0.6	13.5 \pm 0.4	45.6 \pm 0.6	45.6 \pm 0.6	44.1 \pm 0.6	47.6 \pm 0.6	47.6 \pm 0.6	6.6 \pm 0.3	21.4 \pm 0.5	10.9 \pm 0.4	21.4 \pm 0.5	6.6 \pm 0.3	6.6 \pm 0.3	6.6 \pm 0.3	21.4 \pm 0.5	10.9 \pm 0.4	31.9 \pm 0.5	
	Marine Corps (n = 3,194)	74.5 \pm 0.7	16.0 \pm 0.6	12.6 \pm 0.6	45.8 \pm 0.9	40.1 \pm 0.9	12.6 \pm 0.6	40.1 \pm 0.9	40.1 \pm 0.9	51.8 \pm 0.9	51.8 \pm 0.9	51.8 \pm 0.9	6.5 \pm 0.4	18.3 \pm 0.7	8.8 \pm 0.5	18.3 \pm 0.7	6.5 \pm 0.4	6.5 \pm 0.4	6.5 \pm 0.4	18.3 \pm 0.7	8.8 \pm 0.5	31.1 \pm 0.8	
	Navy (n = 5,763)	73.1 \pm 0.6	21.7 \pm 0.5	14.0 \pm 0.5	37.4 \pm 0.6	45.0 \pm 0.7	14.0 \pm 0.5	45.0 \pm 0.7	45.0 \pm 0.7	36.9 \pm 0.6	36.9 \pm 0.6	41.1 \pm 0.6	4.4 \pm 0.3	22.4 \pm 0.5	9.1 \pm 0.4	22.4 \pm 0.5	4.4 \pm 0.3	4.4 \pm 0.3	4.4 \pm 0.3	22.4 \pm 0.5	9.1 \pm 0.4	31.1 \pm 0.6	
	P value (chi-square)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	

¹Sums for sample sizes may not equal the total sample size because some participants did not answer all the questions. CA, combat arms; CS, combat support; CSS, combat service support; DS, dietary supplement; Grad, graduate; HS, high school; Sep, wid, div, separated, widowed, divorced.

²Alcohol consumption: 0.2-24.9 mL/wk = 0.0-1.4 standard drinks; 25.0-71.7 mL/wk = 1.4-4.0 standard drinks; ≥ 71.7 mL/wk = >4.0 standard drinks.

³For rank: junior enlisted, E1-E4; mid-enlisted, E5-E6; senior enlisted, E7-E9; junior officer, O1-O3; senior officer, O4-O7.

products, and purported prohormones. The most often cited DS in the “other” category was fish oils (23.0% \pm 0.5%). DS users spent a mean \pm SD of \$40 \pm \$55/mo on DSs, and 31.0% of users spent $>$ \$50/mo.

Factors associated with DS use

Table 2 shows that a larger proportion of women reported taking DSs, especially MVMs, individual vitamins/minerals, herbals, joint health products, and other DSs; a greater proportion of men reported taking proteins/AAs, combination products, and purported prohormones. The proportion of service members taking DSs generally increased with age, especially MVMs, individual vitamins/minerals, purported prohormones, herbals, joint health products, and other DSs, but generally decreased with age for proteins/AAs and combination products. The proportion of service members taking DSs generally increased with increasing education level, especially MVMs, individual vitamins/minerals, herbals, joint health products, and other DSs; service members with some college education reported using more proteins/AAs, combination products, and purported prohormones. Service members who were separated, widowed, or divorced reported more use of DSs in all categories. As BMI increased, so did the DS use in all categories.

Use of DSs in all categories generally increased with an increase in weekly duration of aerobic training or resistance training. The correlation between weekly aerobic exercise time and weekly resistance training time was 0.61 ($P < 0.01$). Service members who smoked but quit had significantly higher use of DSs than the other 2 groups, especially for MVMs, individual vitamins/minerals, proteins/AAs, joint health products, and other DSs; smokers had significantly higher use of combination products and purported prohormones than the other 2 groups. Smokeless tobacco users who had quit or were still using had the highest DS use, especially proteins/AAs, combination products, purported prohormones, joint health products, and other DSs. As alcohol intake increased there was generally an increase in the use of DSs in all categories except for individual vitamins/minerals.

DS use increased as enlisted rank increased, especially MVMs, proteins/AAs, combination products, joint health products, and other DSs; DS use decreased with rank for purported prohormones and was highest among mid-enlisted service members for individual vitamins/minerals and herbals. Junior officers were more likely to take DSs, especially individual vitamins/minerals, purported prohormones, and herbals, whereas senior officers were more likely to use proteins/AAs and combination products. Those in combat arms occupations had higher use of DSs in most categories except individual vitamins/minerals and herbals, where combat service support had the highest use. Air Force personnel reported significantly lower overall use of DSs and Army personnel significantly higher use than the other services. Compared with the other services, Army personnel reported significantly higher use of MVMs, individual vitamins/minerals, purported prohormones, joint health products, and other DSs. Compared with the other services, Marine Corps personnel had significantly higher use of proteins/AAs and combination products, whereas Navy personnel had significantly higher use of herbals.

Service members taking DSs were more likely to take ≥ 5 DSs than 1-2 or 3-4 DSs. The proportion of service members using ≥ 5 DSs generally increased with an increase in BMI, aerobic training, resistance training, and/or alcohol intake and was highest among Army and Marine Corps personnel.

Multivariable regression

Table 3 presents results of the multivariable logistic regression examining factors associated with DS use. The results presented are for 9 full models with all characteristics entered into the logistic regression. There were 24,010 service members who had complete data on all variables, so 90.0% of participants were included in these analyses.

Factors independently associated with use of any DS included female gender, older age, higher education level, higher BMI, less aerobic exercise, more resistance training, former smoking, current or former smokeless tobacco use, higher alcohol intake, and senior enlisted or officer status. Use of ≥ 5 DSs (≥ 1 time/wk) was independently associated with female gender, older age, higher education level, marriage or former marriage, higher BMI, less aerobic exercise, more resistance training, former smoking, current or former smokeless tobacco use, higher alcohol intake, and service in the Marine Corps. Factors independently associated with use of MVMs included female gender, older age, higher education level, higher BMI, more resistance training, never smoking, smokeless tobacco use, more alcohol intake, officer status, and service in the Air Force (compared with Army service). Use of individual vitamins/minerals was independently associated with female gender, older age, higher education level, separation/widowhood/divorce, higher BMI, more aerobic exercise, more resistance training, and lower rank.

Factors independently associated with use of proteins/AAs included male gender, younger age, higher education level, separation/widowhood/divorce, higher BMI, less aerobic exercise, more resistance training, former smoking, current or former smokeless tobacco use, higher alcohol intake, higher military rank, combat arms occupations (compared with combat service support), and service in the Marine Corps. Use of combination products was independently associated with having some college education, separation/widowhood/divorce, higher BMI, less aerobic training, more resistance training, current or former tobacco use, higher alcohol intake, junior enlisted status (compared with senior officers), and service in the Army or Marine Corps. Factors independently associated with the use of purported prohormones included male gender, older age, separation/widowhood/divorce, higher BMI, less aerobic training, more resistance training, current smokeless tobacco use, higher alcohol intake, and service in the Army, Marine Corps, or Navy (compared with the Air Force). Use of herbals was independently associated with female gender, older age, higher education level, higher BMI, more resistance training, former smokeless tobacco use, higher alcohol intake, and service in the Army or Navy (compared with the Air Force). Factors independently associated with use of joint health products included female gender, older age, higher education level, separation/widowhood/divorce, higher BMI, more resistance training, never smoking, higher alcohol intake, senior officer status, and combat arms occupation (compared with combat service support).

Survey responders and nonresponders (response bias)

Compared with the requested stratified sample, there were a larger proportion of Air Force responders (37%) and a lower proportion of responders from the other services (Army = 30%, Navy = 22%, Marine Corps = 12%), and there was a larger proportion of female responders (14%). Compared with nonresponders, responders were older (mean \pm SD: 33 \pm 8 y compared with 31 \pm 7 y, $P < 0.01$), had more time in service (mean \pm SD: 11 \pm 7 y compared with 9 \pm 7 y, $P < 0.01$),

were more likely to be women (14% compared with 12%, $P < 0.01$), were more likely to have some college or higher education level (55% compared with 39%, $P < 0.01$), and were more likely to be officers (31% compared with 20%, $P < 0.01$). Of 10 occupational groups, those with the highest response rates were infantry (18%), support/administration (17%), mechanical maintenance (14%), electrical repair (12%), health care (12%), and communications/intelligence (11%).

Discussion

This study found that prevalence of DS use in the military services was high, with 74% of service members using ≥ 1 DS ≥ 1 time/wk and 40% of users consuming ≥ 5 DSs/wk. The most commonly used DSs were MVMs (45%), combination products (44%), proteins/AAs (42%), individual vitamins/minerals (31%), herbals (20%), joint health products (9%), and prohormones (5%). Factors independently associated with use of any DS included female gender, older age, higher education level, higher BMI, more resistance training, former smoking, current or former smokeless tobacco use, higher alcohol intake, and higher military rank (senior enlisted or officer). When individual supplements were examined, men were more likely to use proteins/AAs, combination products, and purported prohormones, whereas women were more likely to use MVMs, individual vitamins/minerals, herbals, and joint health products.

The different branches of service were generally surprisingly similar with respect to their use of most types of DSs. Marine Corps personnel were more likely to use proteins/AAs and combination products and less likely to use MVMs and individual vitamins and minerals. Several of these categories of DSs that are used much more frequently by service members than by civilians, specifically combination products and prohormones, are known to be more dangerous than DSs like multivitamins (23).

Prevalence and types of DSs used

In agreement with previous military studies (4–6, 16), service members used more DSs and had a considerably different pattern of DS use than civilians surveyed in the NHANES. This is shown in **Figure 2** which compares NHANES data (7, 24) with those of the current study.

Compared with the broader American population, service members had higher overall DS use and higher use in all comparable categories, especially proteins/AAs. However, there are limitations in comparing civilian and military data related to reporting time frame and sample age. The reporting time frame in the current study was use in the past 6 mo, whereas for the NHANES, it was use in the past 30 d. The NHANES population is older than the military population, and older adults tend to use more DSs than younger adults (24, 25).

The NHANES found DS use among Americans had increased from 23% in 1987 to 52% in 2011–2014 (3, 24, 23, 26). A previous study of Army personnel (19) found that from 2006 to 2011, use of any DS ≥ 1 time/wk increased from 56% to 64%. **Supplemental Table 1** presents data from various military DS studies. Most of these investigations (4, 6, 16, 19) used similar surveys and asked about DS use in the past 6 mo; brand name DSs listed on the questionnaire were updated for DSs that were available on and near military installations when the studies were conducted. One study (5) included broad DS categories (i.e., no brand names) and asked

TABLE 3 Multivariable analysis of factors associated with DS use (≥ 1 time/wk) among US service members, based on self-report for the past 6 mo at the time of survey¹

Variable	Stratum	Any DS	Use of ≥ 5 DSs	Multivitamin /Multimineral	Individual Vitamin/Mineral	Protein or Amino Acid	Combination Product	Purported Prohormone	Herbal	Joint Health Product
Sex	Male	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Female	1.91 (1.73, 2.11)	1.54 (1.41, 1.68)	1.88 (1.74, 2.05)	2.25 (2.07, 2.44)	0.86 (0.79, 0.95)	1.06 (0.97, 1.14)	0.22 (0.15, 0.33)	2.26 (2.06, 2.48)	1.73 (1.52, 1.98)
Age, y	18–24	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	25–29	1.20 (1.07, 1.34)	1.13 (1.02, 1.26)	1.33 (1.20, 1.46)	1.20 (1.07, 1.33)	1.05 (0.94, 1.17)	1.04 (0.94, 1.15)	1.05 (0.83, 1.34)	1.19 (1.05, 1.35)	1.88 (1.52, 2.33)
	30–39	1.27 (1.13, 1.43)	1.22 (1.09, 1.36)	1.53 (1.38, 1.70)	1.43 (1.28, 1.60)	0.90 (0.81, 1.01)	1.07 (0.96, 1.19)	1.54 (1.20, 1.98)	1.32 (1.16, 1.50)	3.00 (2.41, 3.72)
	≥ 40	1.25 (1.08, 1.44)	1.23 (1.07, 1.41)	1.58 (1.39, 1.80)	1.86 (1.62, 2.14)	0.62 (0.54, 0.71)	0.91 (0.79, 1.04)	2.28 (1.70, 3.07)	1.57 (1.34, 1.84)	3.94 (3.08, 5.02)
Education level	Some HS/HS grad	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Some college	1.29 (1.17, 1.43)	1.25 (1.13, 1.37)	1.32 (1.20, 1.44)	1.24 (1.12, 1.37)	1.26 (1.14, 1.39)	1.12 (1.02, 1.22)	0.97 (0.80, 1.18)	1.25 (1.11, 1.40)	1.23 (1.03, 1.47)
Marital status	College degree	1.35 (1.19, 1.53)	1.30 (1.15, 1.46)	1.47 (1.31, 1.65)	1.36 (1.21, 1.54)	1.34 (1.19, 1.52)	1.10 (0.98, 1.24)	1.13 (0.88, 1.44)	1.41 (1.22, 1.62)	1.31 (1.07, 1.62)
	Never married	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
BMI, kg/m ²	Married	0.96 (0.88, 1.04)	1.08 (1.00, 1.16)	0.98 (0.91, 1.06)	1.05 (0.97, 1.13)	1.06 (0.98, 1.14)	1.04 (0.96, 1.12)	1.14 (0.95, 1.36)	0.99 (0.91, 1.08)	1.06 (0.94, 1.22)
	Sep. wid. div	1.07 (0.95, 1.21)	1.29 (1.17, 1.43)	0.96 (0.87, 1.05)	1.19 (1.08, 1.33)	1.21 (1.09, 1.35)	1.18 (1.07, 1.31)	1.82 (1.51, 2.19)	1.10 (0.98, 1.23)	1.34 (1.16, 1.54)
Aerobic exercise duration, min/wk	<25.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	25.0–29.9	1.18 (1.10, 1.26)	1.25 (1.17, 1.33)	1.18 (1.11, 1.25)	1.05 (0.98, 1.12)	1.14 (1.06, 1.22)	1.37 (1.28, 1.46)	1.41 (1.19, 1.67)	1.05 (0.97, 1.13)	1.21 (1.08, 1.35)
Resistance training duration, min/wk	≥ 30.0	1.37 (1.25, 1.52)	1.53 (1.41, 1.68)	1.34 (1.24, 1.46)	1.18 (1.08, 1.28)	1.20 (1.10, 1.32)	1.82 (1.67, 1.98)	1.96 (1.61, 2.38)	1.17 (1.06, 1.30)	1.32 (1.15, 1.51)
	≤ 90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Smoking	91–180	0.87 (0.81, 0.95)	0.78 (0.72, 0.84)	0.95 (0.89, 1.02)	0.92 (0.85, 1.00)	0.79 (0.73, 0.86)	0.83 (0.77, 0.89)	0.90 (0.75, 1.08)	0.95 (0.87, 1.04)	0.98 (0.87, 1.12)
	181–300	0.90 (0.82, 0.99)	0.83 (0.76, 0.90)	0.99 (0.92, 1.07)	1.01 (0.92, 1.09)	0.75 (0.68, 0.81)	0.88 (0.81, 0.96)	0.92 (0.76, 1.10)	1.07 (0.97, 1.17)	1.04 (0.91, 1.19)
Smokeless tobacco use	>300	0.79 (0.71, 0.86)	0.73 (0.67, 0.80)	0.96 (0.89, 1.04)	1.10 (1.01, 1.20)	0.61 (0.55, 0.66)	0.74 (0.68, 0.81)	0.81 (0.68, 0.98)	1.08 (0.98, 1.19)	0.93 (0.81, 1.07)
	≤ 45	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Alcohol intake, mL/wk	46–135	1.50 (1.38, 1.62)	1.71 (1.57, 1.86)	1.24 (1.15, 1.34)	1.16 (1.07, 1.26)	2.40 (2.20, 2.62)	1.54 (1.43, 1.67)	1.55 (1.21, 1.98)	1.29 (1.18, 1.42)	1.43 (1.24, 1.65)
	>300	2.83 (2.59, 3.09)	3.82 (3.52, 4.15)	1.69 (1.57, 1.82)	1.49 (1.37, 1.61)	6.11 (5.60, 6.66)	3.25 (3.00, 3.52)	2.90 (2.32, 3.62)	1.54 (1.40, 1.69)	2.31 (2.02, 2.65)
Smoked but quit	Never smoked	5.05 (4.55, 5.61)	8.21 (7.48, 9.00)	2.39 (2.20, 2.60)	2.04 (1.86, 2.23)	13.09 (11.87, 14.44)	6.39 (5.84, 6.99)	6.15 (4.93, 7.67)	2.05 (1.85, 2.27)	3.47 (2.99, 4.01)
	Smoker	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Used but quit	Never used	1.14 (1.04, 1.24)	1.10 (1.01, 1.19)	1.01 (0.94, 1.09)	1.02 (0.94, 1.10)	1.12 (1.03, 1.22)	1.12 (1.03, 1.21)	0.98 (0.82, 1.14)	0.99 (0.90, 1.09)	0.97 (0.86, 1.10)
	User	1.03 (0.95, 1.13)	0.99 (0.91, 1.07)	0.91 (0.84, 0.98)	0.99 (0.91, 1.07)	0.93 (0.85, 1.01)	1.17 (1.08, 1.26)	1.10 (0.93, 1.29)	1.02 (0.93, 1.12)	0.85 (0.75, 0.97)
Alcohol intake, mL/wk	Never used	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Used but quit	1.39 (1.22, 1.57)	1.21 (1.08, 1.34)	1.08 (0.98, 1.20)	1.08 (0.97, 1.20)	1.20 (1.08, 1.35)	1.35 (1.21, 1.50)	1.21 (0.98, 1.49)	1.14 (1.01, 1.29)	1.12 (0.95, 1.32)
Alcohol intake, mL/wk	User	1.30 (1.17, 1.44)	1.30 (1.19, 1.43)	1.11 (1.02, 1.20)	1.01 (0.92, 1.11)	1.28 (1.17, 1.40)	1.43 (1.30, 1.56)	1.48 (1.26, 1.75)	1.01 (0.91, 1.12)	1.14 (0.99, 1.32)
	0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Alcohol intake, mL/wk	0.2–24.9	1.21 (1.11, 1.31)	1.10 (1.02, 1.19)	1.04 (0.97, 1.12)	1.02 (0.94, 1.10)	1.13 (1.04, 1.23)	1.23 (1.14, 1.33)	1.03 (0.86, 1.23)	1.19 (1.09, 1.30)	1.25 (1.10, 1.42)
	25.0–71.7	1.35 (1.24, 1.47)	1.23 (1.14, 1.33)	1.14 (1.05, 1.22)	1.05 (0.97, 1.13)	1.33 (1.23, 1.44)	1.40 (1.30, 1.52)	1.12 (0.94, 1.33)	1.23 (1.13, 1.35)	1.31 (1.15, 1.49)
≥ 71.7	1.41 (1.29, 1.54)	1.30 (1.20, 1.41)	1.15 (1.06, 1.24)	1.05 (0.96, 1.13)	1.44 (1.32, 1.56)	1.46 (1.34, 1.58)	1.26 (1.07, 1.50)	1.35 (1.23, 1.48)	1.39 (1.22, 1.59)	

(Continued)

TABLE 3 (Continued)

Variable	Stratum	Any DS	Use of ≥5 DSs	Multivitamin /Multimineral	Individual Vitamin/Mineral	Protein or Amino Acid	Combination Product	Purported Prohormone	Herbal	Joint Health Product
Rank ³	Junior enlisted	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Mid-enlisted	1.05 (0.93, 1.18)	1.10 (0.98, 1.24)	1.10 (0.98, 1.23)	0.91 (0.81, 1.03)	1.12 (1.00, 1.27)	1.02 (0.91, 1.15)	1.19 (0.99, 1.60)	0.95 (0.83, 1.10)	1.23 (0.95, 1.59)
	Senior enlisted	1.21 (1.03, 1.41)	1.05 (0.91, 1.22)	1.14 (0.99, 1.31)	0.85 (0.73, 0.98)	1.28 (1.10, 1.49)	1.03 (0.89, 1.19)	1.22 (0.87, 1.72)	0.87 (0.73, 1.03)	1.28 (0.96, 1.71)
	Warrant officer	1.02 (0.80, 1.31)	1.11 (0.88, 1.40)	1.14 (0.92, 1.42)	0.74 (0.59, 0.94)	1.37 (1.08, 1.74)	1.01 (0.81, 1.10)	1.34 (0.85, 2.12)	0.76 (0.58, 1.00)	1.18 (0.80, 1.74)
	Junior officer	1.30 (1.10, 1.53)	1.07 (0.91, 1.24)	1.16 (1.01, 1.35)	0.81 (0.69, 0.94)	1.46 (1.25, 1.70)	0.94 (0.81, 1.10)	0.67 (0.44, 1.00)	0.90 (0.76, 1.08)	1.32 (0.98, 1.78)
	Senior officer	1.26 (1.06, 1.51)	1.09 (0.92, 1.28)	1.32 (1.13, 1.55)	0.90 (0.76, 1.05)	1.37 (1.15, 1.62)	0.80 (0.68, 0.95)	0.69 (0.46, 1.02)	0.82 (0.68, 1.01)	1.45 (1.07, 1.98)
Military occupational specialty	CA	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	CS	0.98 (0.91, 1.06)	1.00 (0.93, 1.07)	1.03 (0.96, 1.10)	1.04 (0.96, 1.12)	0.97 (0.90, 1.05)	0.96 (0.90, 1.04)	1.03 (0.98, 1.19)	0.97 (0.89, 1.06)	0.94 (0.84, 1.05)
	CSS	0.97 (0.90, 1.05)	0.95 (0.88, 1.02)	0.97 (0.90, 1.04)	1.05 (0.97, 1.13)	0.88 (0.82, 0.95)	0.96 (0.89, 1.04)	0.97 (0.83, 1.14)	0.98 (0.90, 1.06)	0.79 (0.70, 0.89)
Service branch	Air Force	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Army	0.95 (0.87, 1.03)	1.07 (0.99, 1.15)	0.88 (0.83, 0.95)	0.96 (0.90, 1.05)	0.96 (0.89, 1.03)	1.11 (1.03, 1.19)	1.60 (1.36, 1.89)	1.10 (1.01, 1.19)	1.02 (0.91, 1.14)
	Marine Corps	1.04 (0.93, 1.15)	1.26 (1.15, 1.39)	0.91 (0.83, 1.00)	0.92 (0.83, 1.02)	1.23 (1.11, 1.36)	1.21 (1.10, 1.33)	1.60 (1.31, 1.96)	1.11 (0.99, 1.24)	1.12 (0.96, 1.31)
	Navy	1.02 (0.93, 1.11)	1.08 (0.99, 1.17)	0.97 (0.90, 1.04)	1.02 (0.95, 1.11)	0.97 (0.90, 1.05)	1.04 (0.96, 1.13)	1.30 (1.08, 1.57)	1.27 (1.16, 1.39)	0.98 (0.87, 1.11)

¹Values are OR (95% CI). Results are for the full model with all variables entered. CA, combat arms; CS, combat support; CSS, combat service support; DS, dietary supplement; Grad, graduate; HS, high school; Sep, wid, div, separated; widowed, divorced.

²Alcohol consumption: 0.2–24.9 mL/wk = 0.0–1.4 standard drinks; 25.0–71.7 mL/wk = 1.4–4.0 standard drinks; ≥71.7 mL/wk = >4.0 standard drinks.

³For rank: junior enlisted, E1–E4; mid-enlisted, E5–E6; senior enlisted, E7–E9; junior officer, O1–O3; senior officer, O4–O7.

about DS use in the past year. Despite these differences, the data in Supplemental Table 1 suggest, in consonance with previous civilian (3, 24, 23, 26) and military (19) data, that overall DS use is increasing over time in all branches of the military. The trends appear to differ depending on the DS category. Limited data suggest that use of MVMs and individual vitamins/minerals increased between 2006 and 2012, but the most recent data from the current study suggest a reduction in use in these categories. Use of proteins/AAs, combination products, herbals, and purported prohormones has increased dramatically among service members.

Combination products in the past have often contained substances like ephedra and 1,3-dimethylamylamine (DMAA) that are now banned in the United States (27, 28). Before the ban on DMAA, 1 study found that 11% of service members were using DSs labeled as containing DMAA, and regular users (≥1 time/wk) were 2 to >3 times more likely to report adverse effects (AEs) (29). Another study found that military users of combination products of any type were 2–3.5 times more likely to report a variety of AEs (e.g., abnormal heartbeats, stomach pain, dizziness), whereas prohormone users were >2.5 times more likely to report dizziness (30). Because combination products and purported prohormones had a high incidence of self-reported AEs (4), this is an area of concern.

Proteins/AAs and combination products are often consumed in conjunction with resistance exercise to purportedly assist in building muscle strength or muscle mass (31) and/or assist in postexercise recovery (32). We hypothesized that increased use of these DSs might be associated with higher levels of resistance training, but this was not the case. In a previous study, Navy and Marine protein/AA or combination product users engaged in a mean ± SD of 280 ± 307 min/wk of resistance training (4), whereas in the present study, this figure was 275 ± 291 min/wk.

Factors associated with DS use

The NHANES (2, 3, 7, 24, 26, 33, 34), National Health Interview Survey (23, 35, 36), and previous military studies (4–6, 16, 17, 37) reported women had higher overall use of DSs, in agreement with both the univariate and multivariable results of the present study. Specifically, women used more MVMs, individual vitamins/minerals, herbals, and joint health products than men. Sex differences may be associated with greater overall health awareness in women, as evidenced by the fact that women are more likely to seek medical care (38–40) and are more likely than men to make behavioral changes to improve health (41–43). Although women had higher use than men in most DS categories, men had higher use of proteins/AAs, combination products, and purported prohormones. This may be because physically active men are more interested in developing strength and muscle mass (44–46) and investigations show physical training with consumption of proteins/AAs will improve these factors (31). Many combination products and purported prohormones are marketed for similar reasons, and they have a high incidence of self-reported AEs (4). Use of these substances may be associated with a greater propensity for men to engage in risky health behaviors than women (47–50).

Similar to findings with regard to DS use and sex, previous civilian (3, 24, 23, 33, 51, 52) and military (4–6, 16, 19) studies have generally found that higher education levels are associated with higher overall DS use. The current investigation also observed this association in univariate and multivariable analysis, especially among users of MVMs, individual vitamins/minerals, herbals, and joint health products. Individuals who have achieved higher education levels are

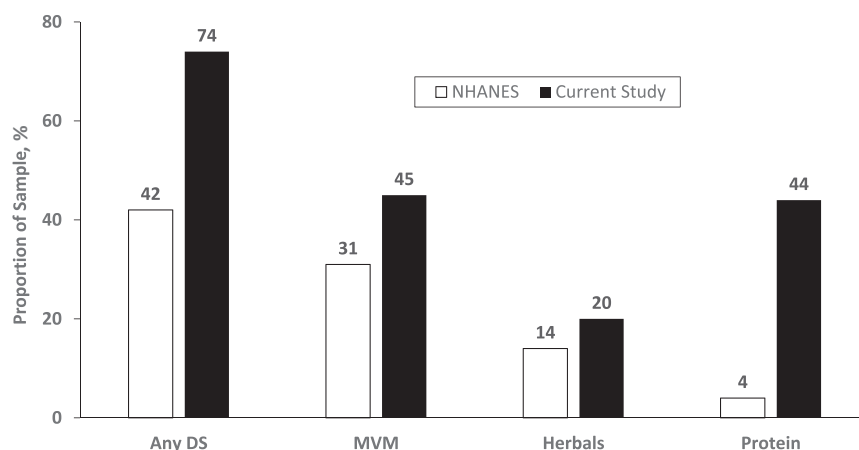


FIGURE 2 Comparison of NHANES data with those of the current investigation. DS, dietary supplement; MVM, multivitamin/multimineral.

generally more proactive, more health conscious, more prone to engage in health-promoting behaviors, and more likely to explore multiple channels of information related to their health (53–57), which may lead to higher use of some types of DSs (58–60).

Whereas civilian studies have consistently shown use of any DS (2, 3, 7, 24, 26, 33, 34, 61) and use of MVMs (2, 7, 24, 23, 34, 52) increase with age in adults, this association appears more complex among military personnel. In the present study, overall DS use was lowest in the youngest (18–24 y) age group and changed only modestly in older age groups. Analysis of the present and previous studies (4–6, 16, 19) suggested this was largely because of the types of DSs used. In univariate analysis, use of MVMs, individual vitamins/minerals, purported prohormones, herbals, and joint health products increased with age, whereas use of proteins/AAs and combination products generally had the highest use prevalence in younger age groups. Thus, whereas use of certain categories of DSs increases with age, other categories have high use among younger service members, resulting in the trend seen in overall usage. In multivariable analysis, most of these relations were maintained, but age was not independently associated with combination product use, although the trend was in the expected direction.

Whereas civilian studies (2, 3, 24, 26, 36) have shown virtually no association between BMI and DS use, military studies (4, 5, 16, 19) are generally consistent in showing that overall use of DSs increases as BMI increases. Among service members in the current and past studies (4, 16), the strongest associations in both univariate and multivariable analyses have been between BMI and combination product use. Many combination products are alleged to assist in weight or fat loss. Studies (5, 62, 63) that specifically examined weight loss supplements in military populations showed a 3.2- to 3.8-fold increase in weight loss supplement use comparing service members with normal BMIs (<25) and those with obese BMIs (≥ 30). Military service regulations describe strict weight for height and body fat standards required to continue military service (64–67). Individuals who do not meet these standards receive adverse performance reports and can be discharged from service for repeated failures to achieve the standards. This may prompt some individuals who have difficulty meeting these requirements to use DSs marketed for weight or body fat loss.

Higher amounts of exercise or physical activity have been associated with higher DS use in both civilian (2, 26, 68) and military investigations (5, 6, 17, 62) or showed trends in this direction (4, 16, 34). In the current study, the use of DSs in all categories generally increased as physical activity increased. In multivariable analysis, the relation between aerobic training and DS use was considerably reduced because of the much larger association between resistance training and DS use. As aerobic training time increased so did resistance training time, and the correlation between these variables was 0.61. Individuals who have higher levels of physical activity tend to have other favorable health habits (69–71) and may perceive certain DSs to be an additional way to improve their health and performance. In the present study, it was notable that there was an ~3-fold increase in protein/AA and combination product use among the most active resistance training service members compared with the least active resistance trainers. Pre- and postexercise use of proteins/AAs has been shown to increase muscle mass and strength (31), and many combination products are promoted for increasing strength and muscle mass and for their ergogenic effects (72, 73), which likely encourages more active service members to use them.

Tobacco use and excessive alcohol consumption are risky health behaviors because of their associations with chronic diseases, mortality, and injuries (74–76). Combination products and purported prohormones are those with the highest risk of AEs (4), and the association between these 2 categories of DSs and tobacco/alcohol use was graded. That is, smokers and smokeless tobacco users had the highest use of these substances, those who had never smoked had the least, and those who had quit were intermediate between these 2; use of these DSs increased as alcohol consumption increased. The only study (62) examining the relation between DS use and these lifestyle factors in military personnel found that use of body-building, weight-loss, and performance-enhancing DSs increased as alcohol consumption increased. Previous civilian studies found no consistent relation (2, 24, 26, 34), and the reasons for the differences between military and civilian populations are not clear.

Strengths and limitations

The current study had the advantage of recruiting a large, stratified, random sample of service members from all branches of service. The questionnaire was standardized and based

on questionnaires used in previous military studies (18). The demographics and lifestyle factors examined were similar to those of other civilian and military investigations, which allowed for satisfactory comparisons among studies. However, the service members who volunteered differed somewhat from the desired stratified sample, although both sexes and all service branches were well represented. The 18% response rate was relatively low, but close to the 20% response rate expected for military survey studies conducted by the NHRC that investigate topics other than DSs. Although the questionnaire instructions and consent form emphasized the importance of both DS user and nonuser participation, it is possible the questionnaire may have attracted more DS users. All data were self-reported and had the usual weaknesses associated with this method, including recall bias, social desirability, errors in self-observation, and inadequate recall (77, 78).

Conclusions

In the current study using a stratified random sample of >26,000 service members, 74% reported DS use, with the highest use for MVMs (45%), combination products (44%), and proteins/AAs (42%). As the volume of resistance training increased, DS use in all categories increased, especially for proteins/AAs and combination products. Compared with the civilian data assessed in the NHANES, service members were much more likely to use DSs and to use different types of DSs, especially combination products and proteins/AAs. Comparisons with previous military data suggested DS use has increased over time among service members in all service branches, especially use of proteins/AAs, combination products, herbals, and purported prohormones. This article provides basic information on the current prevalence of DS use by military personnel and how demographic, lifestyle, and military factors affect use. The Institute of Medicine report on DS use in the military (15) suggested that conducting ongoing surveillance of DS use in the military was essential for protecting the health of service members.

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