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Dietary Supplement Use by US Adults: Data from the National Health and Nutrition Examination Survey, 1999–2000

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Data from the 1999–2000 National Health and Nutrition Examination Survey, a nationally representative, cross-sectional survey of US health and nutrition, were analyzed to assess prevalence of dietary supplement use overall and in relation to lifestyle and demographic characteristics. Fifty-two percent of adults reported taking a dietary supplement in the past month; 35% took a multivitamin/multimineral. Vitamin C, vitamin E, B-complex vitamins, calcium, and calcium-containing antacids were taken by more than 5% of adults. In bivariate analyses, female gender, older age, more education, non-Hispanic White race/ethnicity, any physical activity, normal/underweight, more frequent wine or distilled spirit consumption, former smoking, and excellent/very good self-reported health were associated with greater use of any supplement and of multivitamin/multiminerals; in multivariable comparisons, the latter three characteristics were not associated with supplement use. Most supplements were taken daily and for at least 2 years. Forty-seven percent of adult supplement users took just one supplement; 55% of women and 63% of adults aged ≥60 years took more than one. These findings suggest that, to minimize possible spurious associations, epidemiologic studies of diet, demography, or lifestyle and health take dietary supplement use into account because of 1) supplements' large contribution to nutrient intake and 2) differential use of supplements by demographic and lifestyle characteristics.

adult; antacids; dietary supplements; health surveys; minerals; nutrition surveys; vitamins

Abbreviations: CI, confidence interval; NHANES, National Health and Nutrition Examination Survey; OR, odds ratio; UL, Upper Intake Levels.

The Dietary Supplement Health and Education Act of 1994 (1) assured consumer access to a wide range of dietary supplements. Dietary supplements of all varieties are now marketed in the United States, including single-ingredient products and various combinations of vitamins, minerals, botanicals, and other constituents. Media attention to supplements, including advertisements, informational articles, and studies reporting associations with health conditions, is considerable. Marketing data show a dramatic increase in supplement sales since 1997, which totaled approximately $18.8 billion in 2003 (2).

Consequently, current detailed data on the prevalence of supplement use and characteristics of users are needed to inform the design, analysis, and interpretation of epidemiologic studies of diet or lifestyle and health. A high prevalence of vitamin and mineral supplement use would call for assessment of supplement use in any study that requires nutrient intake data, since supplements often contain 100 percent or more of the daily value of one or more nutrients. Differences in demographic and behavioral characteristics between supplement users and nonusers would demonstrate the importance of including supplement assessment in both the planning and analysis of any epidemiologic study of diet or lifestyle characteristics and health, to minimize findings derived from confounding with supplement intake rather than from the characteristic itself. Caveats regarding the generalizability of findings from groups with nonrepresentative lifestyles or demographics would also be indicated. At present, the only published, nationally representative data on dietary supplement use collected since the Dietary Supple-

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ment Health and Education Act was passed in 1994 are those from the Continuing Survey of Food Intake by Individuals 1994–1996, which show higher use by women versus men and the highest use by women aged 50–59 years but do not present data by other demographic or lifestyle characteristics (3).

The National Health and Nutrition Examination Survey (NHANES) is a nationally representative survey that comprises medical examinations and tests as well as detailed questions about participants' health, lifestyle, and diet, including dietary supplement use. This paper presents NHANES 1999–2000 data on the prevalence and details of use of any dietary supplement, and of specific vitamin and mineral supplements for the US population aged 20 years or older, and on associations of use with select demographic and lifestyle characteristics.

MATERIALS AND METHODS

The NHANES survey

NHANES is designed to monitor the health and nutritional status of the US population (4). A nationally representative sample of the US civilian, noninstitutionalized population is selected using a complex, stratified, multistage probability cluster sampling design. Selected population subgroups of particular interest are oversampled to obtain sufficient numbers to reliably estimate health and nutrition parameters. In 1999–2000, oversampled groups included people with low incomes, African Americans, Mexican Americans, adolescents, people 60 years of age or older, and pregnant women. The survey consists of a home interview averaging about 1 hour and an examination in the NHANES mobile examination unit lasting up to several hours.

Topics in the 1999–2000 NHANES interview included self-reported race/ethnicity, education, health insurance, smoking, current and past medical conditions, weight and weight history, diet behavior, alcohol intake, physical activity and fitness, and overall health (5). Many questions refer to the past month. The 1999–2000 examination included numerous blood biochemistries, body composition, audiometry, oral health, vision, cardiovascular fitness, and a physician's examination (5). Additional details about the methods and measures, including the exact wording of questions, are available on the Internet (4–8). The NHANES 1999–2000 sample included 4,880 adults 20 years of age or older. Response rates for the interview were 82 percent in 1999–2000.

Covariates

All covariates used in these analyses were self-reported data obtained from the home interview. Body mass index was calculated from self-reported height and weight (kilograms/meters squared). Measured height and weight were available; however, analytic results were nearly identical to those from self-report, so the latter were used to maintain consistency with other variables and the larger sample size. Classifications of body mass index were <25.0 (normal or underweight), 25.0–29.9 (overweight), and ≥30.0 (obese) (9). Pregnant women were asked to report their prepregnancy weight. Physical activity referred to self-report of vigorous activity causing heavy sweating or a large increase in breathing or heart rate and of moderate activity causing light sweating or a slight-to-moderate increase in breathing or heart rate for at least 10 minutes in the past month. Any report of vigorous activity was classified as vigorous, a report of moderate but no vigorous activity was classified as moderate, and a report of neither was classified as no physical activity.

Dietary supplement data collection

Dietary supplement intake was assessed by asking participants whether they had taken any vitamins, minerals, or other dietary supplements, including prescription supplements, in the last month. They were shown a card with examples of many types of supplements (Appendix table 1). Interviewers asked to see participants' supplement containers, and they recorded the name and manufacturer of each supplement from the label. If the container was not seen (22 percent of the time), the interviewer asked for the exact name of the product or, if not known, the supplement type, for example, multivitamin, vitamin C. Participants were asked how long they had been taking this product, how often, and how much they took. Information on as many as 20 supplements could be recorded. Antacids were recorded separately unless the participant reported using them as a calcium supplement. Methods are described in more detail elsewhere (4–8).

Data preparation

Trained NHANES nutritionists matched reported supplements and antacids to known products (7). The supplements and calcium-containing antacids were then categorized by NHANES nutritionists (Appendix table 2).

Dietary supplement use prevalence was estimated using sampling weights for each person to account for differential probabilities of selection and nonresponse. Sample weights were poststratified to US Census Bureau estimates of the population to yield representative estimates (10, 11). Because only interview data were used in these analyses, interview weights were used.

Statistical analysis

Statistical analyses were carried out using SAS for Windows (SAS Institute, Inc., Cary, North Carolina) and SUDAAN software (Research Triangle Institute, Research Triangle Park, North Carolina). Standard errors for prevalence were calculated by using the delete 1 jackknife method (10, 12), partitioning the sample into 52 sampling units and forming 52 replicates deleting one unit at a time. Differences between prevalence rates were assessed with two-sided t tests. Because of the numerous comparisons possible, only differences of $p < 0.005$ are noted. Prevalence estimates and comparisons of the number, frequency, and duration of supplements taken were based on the sample of all 4,862 adults aged 20 years or older for whom dietary supplement data were available.

TABLE 1. Prevalence* (% (standard error)) of dietary supplement† use in the past month among US adults aged 20 years or older, by gender and age, National Health and Nutrition Examination Survey, United States, 1999–2000

Characteristic	No. of adults	Any dietary supplement‡	Multivitamin/ multimineral	Vitamin E	Vitamin C	Calcium	Calcium/ antacids	B-complex vitamins
Total	4,862	52.0 (1.4)	35.0 (1.3)	12.7 (0.9)	12.4 (0.9)	10.4 (0.8)	24.4 (1.3)	5.2 (0.5)
Gender								
Male	2,260	46.9 (1.5)	31.7 (1.5)	11.7 (1.1)	12.2 (1.1)	3.9 (0.6)	18.9 (1.3)	4.4 (0.6)
Female	2,602	56.7 (1.7)	38.0 (1.6)	13.5 (1.0)	12.6 (1.0)	16.4 (1.3)	29.5 (1.6)	5.8 (0.8)
Age (years)								
20–39	1,692	43.3 (1.8)	30.4 (1.7)	4.4 (0.7)	8.9 (1.1)	3.8 (0.7)	16.7 (1.2)	2.6 (0.5)
40–59	1,345	56.1 (1.9)	37.8 (1.9)	15.3 (1.7)	13.7 (1.7)	13.8 (1.6)	28.7 (2.0)	7.1 (1.2)
≥60	1,825	63.3 (1.7)	39.8 (2.1)	25.3 (1.5)	17.3 (1.6)	18.4 (1.3)	33.5 (1.9)	7.2 (0.8)
		Chromium	Iron	Folic acid	Vitamin A	Vitamin B_{12}	Selenium	Zinc
Total	4,862	2.2 (0.4)	1.8 (0.3)	1.4 (0.2)	1.3 (0.2)	1.2 (0.2)	1.1 (0.3)	1.1 (0.2)
Gender								
Male	2,260	2.2 (0.5)	0.5 (0.2)§	1.1 (0.2)	1.2 (0.3)	0.8 (0.3)§	1.1 (0.3)	1.0 (0.3)
Female	2,602	2.3 (0.4)	3.1 (0.5)	1.6 (0.3)	1.5 (0.3)	1.5 (0.3)	1.0 (0.3)	1.1 (0.3)
Age (years)								
20–39	1,692	2.1 (0.5)	2.1 (0.4)	0.6 (0.2)§	1.0 (0.3)	0.6 (0.3)§	0.4 (0.2)§	0.8 (0.3)§
40–59	1,345	3.3 (0.8)	1.5 (0.4)	1.9 (0.4)	1.5 (0.4)	0.9 (0.3)§	1.6 (0.5)§	1.0 (0.4)§
≥60	1,825	0.8 (0.3)§	1.9 (0.4)	2.1 (0.4)	1.8 (0.5)	2.9 (0.6)	1.6 (0.4)	1.9 (0.4)

* Sample weights were poststratified to the 2000 US Census Bureau estimates of the population but are otherwise unadjusted.

† Any dietary supplement and vitamin or mineral supplements with more than a 1% prevalence of usage and combined calcium supplements plus calcium-containing antacids not taken as dietary supplements.

‡ Refer to Appendix table 2 for supplement classification.

§ Estimate does not meet the minimum standard of statistical reliability (relative standard error >30%).

Multivariable logistic regression was undertaken to assess associations of supplement use with demographic and lifestyle characteristics of interest while simultaneously accounting for the other characteristics. Each demographic/lifestyle characteristic included in the logistic regression model was associated with the prevalence of at least two supplement types in pairwise comparisons. Trend was assessed by assigning integer scores to variables with at least three hierarchical categories and then treating them as continuous, assuming a linear relation. Geometric means of the number of supplements taken were used to account for the skewed distribution. Logistic regression was based on the smaller sample of the 4,453 participants with complete data for all variables that were included in the regression model.

RESULTS

Prevalence of supplement use

Fifty-two percent of adults in our study (47 percent of men, 57 percent of women) had taken a dietary supplement in the previous month (table 1). Most commonly reported were multivitamin/multiminerals (35 percent), usually a standard or senior formula, and vitamins E and C (12–13 percent). Ten percent reported taking calcium supplements, which increased to nearly 25 percent when calcium-containing antacids not recorded as dietary supplements were included. Use of B-complex vitamins was reported by 5 percent. Other vitamin or mineral supplements for which prevalence rates were greater than 1 percent are presented in table 1. Those for which the rates were 1 percent or less, not presented in any table, included potassium, thiamin, riboflavin, niacin, beta-carotene, molybdenum, magnesium, multiminerals, vitamin B_6, and vitamin K.

Bivariate analysis

Comparisons of use of specific supplement types by demographic/lifestyle characteristics (tables 1 and 2) revealed a number of consistent patterns. Use of any supplement and the most commonly taken supplements was usually higher for women than for men, for participants aged 60 years or older versus 20–39 years, for non-Hispanic Whites versus non-Hispanic Blacks and Mexican Americans, for participants with more than a high school education versus less, for those reporting moderate versus no physical activity, and for former versus current smokers ($p < 0.005$ for all comparisons except B-complex vitamins). Use of any supplement and of multivi-

TABLE 2. Prevalence* (% (standard error)) of dietary supplement† use among US adults aged 20 years or older, by demographic and lifestyle characteristics, National Health and Nutrition Examination Survey, United States, 1999–2000

Characteristic	No. of adults	Any supplement‡	Multivitamin/ multimineral	Vitamin E	Vitamin C	Calcium	Calcium/ antacids	B-complex vitamins
Total	4,862	52.0 (1.4)	35.0 (1.3)	12.7 (0.9)	12.4 (0.9)	10.4 (0.8)	24.4 (1.3)	5.2 (0.5)
Race/ethnicity§								
Non-Hispanic White	2,229	58.2 (1.9)	39.8 (1.7)	15.5 (1.3)	14.7 (1.2)	12.4 (1.0)	29.4 (1.6)	5.9 (0.7)
Non-Hispanic Black	922	36.0 (2.2)	23.0 (1.4)	5.4 (0.8)	5.1 (0.7)	3.2 (0.6)	9.1 (1.3)	2.7 (0.6)
Mexican American	1,276	33.3 (2.3)	20.5 (1.6)	4.9 (0.9)	4.5 (0.7)	5.6 (0.9)	13.5 (1.5)	2.5 (0.7)
Education								
Less than high school	1,888	34.7 (2.1)	21.4 (1.3)	7.5 (1.0)	5.7 (0.8)	7.3 (1.0)	18.3 (1.8)	1.9 (0.4)
High school diploma	1,095	48.4 (2.2)	30.5 (1.9)	11.2 (1.3)	9.9 (1.1)	9.9 (1.4)	25.2 (2.0)	4.3 (0.7)
More than high school	1,863	62.2 (1.6)	43.9 (1.8)	16.0 (1.5)	16.9 (1.5)	12.2 (1.1)	27.1 (1.6)	7.2 (0.9)
Reported body mass index (kg/m^2)								
<25.0	1,724	56.8 (2.0)	39.5 (1.7)	12.9 (1.1)	13.1 (1.4)	11.8 (1.1)	22.8 (1.5)	5.0 (0.9)
25.0–<30.0	1,646	51.7 (2.0)	34.3 (1.7)	14.0 (1.5)	13.1 (1.4)	10.0 (1.1)	24.2 (1.8)	5.6 (0.7)
≥30.0	1,293	46.3 (1.8)	30.1 (1.8)	10.7 (1.5)	10.8 (1.4)	8.8 (1.2)	27.9 (1.7)	4.9 (0.8)
Physical activity								
None	2,483	42.5 (1.6)	26.4 (1.6)	10.2 (1.0)	10.2 (1.0)	8.4 (0.9)	19.9 (1.6)	3.6 (0.5)
Moderate	1,106	58.9 (2.3)	40.6 (2.2)	15.3 (1.2)	13.7 (1.2)	14.1 (1.4)	30.6 (2.1)	6.5 (1.1)
Vigorous	1,253	58.5 (2.2)	41.3 (2.2)	13.7 (1.9)	14.0 (1.6)	10.2 (1.3)	25.1 (2.3)	6.0 (0.9)
Self-reported health								
Excellent/very good	2,136	54.9 (1.7)	38.8 (1.5)	13.2 (1.2)	13.5 (1.1)	10.7 (1.0)	23.3 (1.5)	4.9 (0.6)
Good	1,499	49.6 (1.9)	31.6 (1.9)	12.4 (1.0)	12.2 (1.3)	9.9 (1.0)	26.0 (1.7)	4.9 (0.7)
Fair/poor	1,223	46.7 (2.1)	28.5 (1.8)	11.6 (1.5)	8.7 (1.7)	10.4 (1.6)	25.3 (2.0)	6.3 (1.2)
Cigarette smoking								
Never	2,561	52.2 (1.9)	36.0 (1.8)	13.9 (1.4)	12.8 (1.2)	11.5 (0.1)	23.3 (1.5)	6.2 (0.7)
Former	1,297	61.2 (2.1)	41.6 (1.9)	16.7 (1.4)	14.8 (1.2)	14.0 (1.6)	30.5 (1.8)	4.8 (1.0)
Current	996	43.0 (1.8)	26.6 (1.7)	6.3 (1.0)	9.2 (1.2)	4.5 (0.8)	20.9 (2.0)	3.4 (0.7)
Beer consumption								
Never	3,089	52.7 (1.6)	34.2 (1.4)	13.9 (0.9)	11.8 (0.9)	12.7 (1.0)	26.2 (1.6)	5.7 (0.8)
1–4 times/month	888	51.8 (2.0)	35.0 (2.4)	11.6 (1.5)	13.1 (1.4)	7.8 (1.0)	21.0 (1.6)	3.8 (0.7)
≥5 times/month	749	49.9 (2.6)	36.4 (2.7)	11.2 (1.8)	13.9 (1.9)	6.4 (1.4)	22.8 (2.3)	4.8 (1.1)
Wine consumption								
Never	3,651	47.4 (1.4)	31.4 (1.3)	10.6 (0.8)	10.2 (0.8)	8.8 (0.7)	23.2 (1.3)	4.5 (0.6)
1–4 times/month	721	59.0 (2.6)	39.6 (2.5)	15.7 (2.2)	15.9 (1.8)	13.3 (1.5)	26.3 (2.1)	6.6 (1.1)
≥5 times/month	339	71.7 (3.2)	50.9 (3.7)	24.1 (3.4)	22.6 (3.1)	17.3 (3.1)	31.2 (3.6)	7.1 (1.7)
Distilled spirits consumption								
Never	3,728	50.6 (1.6)	33.1 (1.5)	12.7 (0.9)	11.9 (0.8)	10.4 (0.7)	23.2 (1.3)	5.2 (0.7)
1–4 times/month	694	52.9 (2.3)	36.2 (2.4)	12.2 (1.8)	12.4 (1.9)	10.9 (1.6)	27.1 (2.3)	4.5 (1.1)
≥5 times/month	298	61.9 (2.8)	46.7 (2.8)	16.9 (3.3)	19.1 (3.4)	9.4 (3.4)¶	30.7 (3.6)	6.3 (2.5)¶

* Sample weights were poststratified to the 2000 US Census Bureau estimates of the population but are otherwise unadjusted.
† Any dietary supplement and vitamin or mineral supplements with at least a 5% prevalence of usage and combined calcium supplements plus calcium-containing antacids not taken as dietary supplements.
‡ Refer to Appendix table 2 for supplement classification.
§ Data for race/ethnicity categories Other and Other Hispanic not shown ($n = 435$) but are included in the total.
¶ Estimate does not meet the minimum standard of statistical reliability (relative standard error >30%).

tamin/multiminerals was also greater for participants with more than a high school education versus a high school education, under- or normal-weight people, those reporting vigorous versus no activity, those reporting excellent/very good health versus fair/poor health, never versus current smokers, and participants who drank wine or distilled spirits

five or more times per month compared with those who abstained ($p < 0.005$ for all comparisons).

Multivariable analysis

Table 3 presents adjusted odds ratios with 95 percent confidence intervals for demographic/lifestyle variables associated with the most common supplement types, any supplement, and combined calcium/antacids. Older age and higher education remained positively associated with dietary supplement use for all supplement types. Greater physical activity was positively associated with all types except vitamin C. Particularly high were positive associations of older age with vitamin E (odds ratio (OR) = 9.1, 95 percent confidence interval (CI): 6.5, 12.9) and calcium (OR = 6.2, 95 percent CI: 3.9, 9.7) use, higher education with B-complex vitamin use (OR = 5.1, 95 percent CI: 2.9, 9.2), and female gender with calcium use (OR = 5.5, 95 percent CI: 3.8, 7.9). In general, Mexican Americans and non-Hispanic Blacks were less likely than non-Hispanic Whites to take supplements. Particularly low was non-Hispanic Blacks' use of calcium and combined calcium/antacids (OR = 0.3, 95 percent CI: 0.2, 0.4 for both) and vitamins C (OR = 0.4, 95 percent CI: 0.3, 0.6) and E (OR = 0.4, 95 percent CI: 0.3, 0.7). There was no association of B-complex vitamin supplements with race/ethnicity. More frequent wine intake was positively associated with use of any supplement and multivitamin/multiminerals, vitamin C, and vitamin E but not of calcium, combined calcium/antacids, or B-complex vitamins. Increasing body mass index was associated with less use of any supplement and multivitamin/multimineral supplements and with greater combined calcium/antacid use, but not with other supplement types. Compared with never smokers, current smokers were less likely to take vitamin E or calcium. In multivariable analyses, poor self-reported health was associated only with greater B-complex vitamin use.

Details of supplement use

Forty-seven percent of supplement users took only one supplement (table 4); only 5 percent took more than six (data not shown). More men than women took just one supplement ($p < 0.01$), but the mean number taken was similar ($p = 0.06$). Use of only one supplement decreased with age ($p < 0.001$), mean number increased with age ($p < 0.01$), and older people took more supplements than younger ones did ($p < 0.001$). Only two participants reported taking the maximum of 20 supplements.

At least 89 percent of the four most common supplement types were taken 30 times a month or more; B-complex vitamins and combined calcium/antacids use was less frequent (table 5). Over half of the users of each type except multivitamin/multiminerals had taken them for 2 years or more; over a fifth of vitamin C, vitamin E, and calcium/antacid users had taken them for at least 10 years.

DISCUSSION

Prevalence of dietary supplement use

These NHANES 1999–2000 data are the most recent nationally representative data available on comprehensive dietary supplement use. They indicate that over half of US adults aged 20 years or older took at least one dietary supplement some time during the preceding month. The most commonly used supplements were multivitamin/multiminerals (35 percent), vitamin C, vitamin E, and calcium. Supplements of other nutrients of interest in relation to health, such as selenium, folic acid, beta-carotene, zinc, and chromium, were reported infrequently in 1999–2000.

Comparison of NHANES 1999–2000 findings with those from previous NHANES surveys, which used similar methodology, suggests that supplement use has increased. Results from the Third NHANES survey (1988–1994) ranged from 30 to 42 percent for men and 42 to 55 percent for women (13). Prevalence rates for adults were 35 percent in the Second NHANES survey and 23 percent in the First NHANES survey (14, 15). Other supplement surveys have used different methodologies and time frames. Prevalence of adult supplement use reported in the National Health Interview Survey was 46.2 percent (1992) and 51.1 (1987) percent for the past year (16) and 36 percent for the past 2 weeks (1986) (17). The 1994–1996 Continuing Survey of Food Intake by Individuals reported 42 percent of men and 56 percent of women taking any vitamin or mineral supplement; no time referent was used (3). Analyses of previous supplement surveys have found demographic/lifestyle characteristic associations similar to NHANES: higher usage rates among women, Whites, older people, the more highly educated, and former smokers (3, 13–18).

Strengths and weaknesses of the NHANES data collection procedure

Strengths of the NHANES supplement data collection are its nationally representative sample and the in-person interview and transcription of the supplement name and manufacturer from the supplement container, which is then matched to a supplement label. Other studies (19, 20) have used a procedure similar to the NHANES method as their reference method to assess validity of self-reported dietary supplement use by questionnaire or via a telephone interview. Additionally, NHANES supplement data are categorized by nutritionists based on standardized classification rules regarding the product name and ingredients. Such a labor-intensive procedure is important for accurate data collection and categorization. Other collection procedures cannot be assumed to achieve this quality of data. To our knowledge, validity of self-report of supplements by type, a commonly used method (3, 16–18), has not been assessed. As supplements become more complex, containing a variety of ingredients, self-categorization may become more problematic, increasing the need for validation studies of such methods.

Some limitations of the NHANES data are the short referent time frame of the past month, which is used to increase accuracy of self-report and for comparability with other NHANES data that use this time frame. However, results are difficult to compare with studies that assess annual supplement use, especially for supplements used for a short term as medications. Additionally, because the data are cross-sectional, analyses of supplement use with the many health conditions measured in NHANES cannot

TABLE 3. Odds ratios and 95% confidence intervals from multivariate analyses of demographic and lifestyle characteristics associated with dietary supplement* use by US adults, National Health and Nutrition Examination Survey, United States, 1999–2000 (*n* = 4,453)

Characteristic	Any supplement†		Multivitamin/ multimineral		Vitamin E		Vitamin C		Calcium		Calcium/antacids		B-complex vitamins	
	OR‡,§	95% CI§	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Gender														
Male	1.0		1.0		1.0		1.0		1.0		1.0		1.0	
Female	1.6	1.3, 1.8	1.4	1.2, 1.7	1.1	0.9, 1.4	1.1	0.8, 1.4	5.5	3.8, 7.9	2.0	1.7, 2.5	1.3	0.8, 2.2
Age (years)														
20–39	1.0		1.0		1.0		1.0		1.0		1.0		1.0	
40–59	1.7	1.4, 2.1	1.4	1.1, 1.7	3.9	2.6, 5.9	1.6	1.0, 2.4	4.4	2.8, 6.8	1.9	1.5, 2.4	3.0	1.7, 5.4
≥60	2.7	2.2, 3.3	1.7	1.3, 2.2	9.1	6.5, 12.9	2.6	1.7, 3.8	6.2	3.9, 9.7	2.4	2.0, 2.9	3.6	2.1, 6.0
p trend	<0.01		<0.01		<0.01		<0.01		<0.01		<0.01		<0.01	
Race/ethnicity¶														
Non-Hispanic White	1.0		1.0		1.0		1.0		1.0		1.0		1.0	
Non-Hispanic Black	0.5	0.4, 0.7	0.6	0.5, 0.7	0.4	0.3, 0.7	0.4	0.3, 0.6	0.3	0.2, 0.4	0.3	0.2, 0.4	0.6	0.3, 1.1
Mexican American	0.6	0.5, 0.8	0.6	0.5, 0.8	0.6	0.4, 0.9	0.5	0.3, 0.8	0.7	0.5, 1.1	0.5	0.4, 0.7	0.9	0.5, 1.6
Education														
Less than high school	1.0		1.0		1.0		1.0		1.0		1.0		1.0	
High school diploma	1.5	1.2, 1.9	1.3	1.0, 1.6	1.4	0.9, 2.2	1.6	1.1, 2.3	1.1	0.7, 1.9	1.2	0.9, 1.6	2.9	1.5, 5.7
More than high school	2.4	1.9, 3.2	2.0	1.5, 2.6	2.2	1.5, 3.3	2.8	1.8, 4.4	1.6	1.0, 2.4	1.4	1.1, 1.8	5.1	2.9, 9.2
p trend	<0.01		<0.01		<0.01		<0.01		0.01		0.01		<0.01	
Reported body mass index (kg/m^2)														
<25.0	1.0		1.0		1.0		1.0		1.0		1.0		1.0	
25.0–<30.0	0.8	0.6, 1.0	0.8	0.7, 1.0	1.0	0.8, 1.4	1.0	0.7, 1.5	0.9	0.7, 1.2	1.1	0.9, 1.4	1.1	0.7, 1.8
≥30.0	0.7	0.6, 0.9	0.7	0.6, 0.9	0.8	0.6, 1.2	1.0	0.6, 1.4	0.7	0.5, 1.1	1.4	1.1, 1.9	1.0	0.6, 1.8
p trend	0.01		0.01		0.54		0.86		0.38		<0.01		0.78	
Physical activity														
None	1.0		1.0		1.0		1.0		1.0		1.0		1.0	
Moderate	1.6	1.3, 1.9	1.5	1.2, 1.9	1.2	0.9, 1.6	1.0	0.8, 1.3	1.7	1.2, 2.4	1.6	1.3, 2.0	1.6	0.9, 2.7
Vigorous	1.8	1.4, 2.4	1.7	1.3, 2.3	1.7	1.2, 2.5	1.2	0.8, 1.6	1.9	1.3, 2.8	1.6	1.2, 2.2	2.0	1.2, 3.2
p trend	<0.01		<0.01		0.01		0.43		<0.01		<0.01		0.01	

Table continues

presume any causality, only a concurrent or subsequent association. While recording of the supplement name from the label is a strength compared with many other studies, it is still subject to some error. Capture of the label image would improve data collection. Additionally, analytic verification of the supplement's actual ingredient content would be required to accurately depict nutrient content.

Implications of findings for nutrient intake

The high prevalence of daily multivitamin/multimineral supplement use seen in the NHANES 1999–2000 data suggests adequate intake of a large number of important vitamins and minerals by a sizable proportion of US adults. However, some supplements list nutrients at levels at or above the Upper Intake Levels (UL) set by the National Academy of Sciences (21). Most multivitamin/multimineral labels listed nutrients below the UL; however, some listed amounts at or above the UL for niacin, magnesium, zinc, iron, folate, vitamin B_6, vitamin C, and vitamin A. On some B-complex vitamin labels, niacin and B_6 exceeded the UL. Some single- or double-nutrient supplements, such as vitamin A, vitamin C, vitamin B_6, iron, zinc, and calcium plus magnesium, listed amounts at or near the UL. Additionally, a person taking several magnesium-containing antacids could be at risk of exceeding the UL for magnesium. While

TABLE 3. Continued

Characteristic	Any supplement†		Multivitamin/ multimineral		Vitamin E		Vitamin C		Calcium		Calcium/ antacids		B-complex vitamins	
	OR‡	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Self-reported health														
Excellent/very good	1.0		1.0		1.0		1.0		1.0		1.0		1.0	
Good	1.0	0.8, 1.2	0.9	0.7, 1.1	1.0	0.8, 1.3	1.0	0.8, 1.4	1.0	0.7, 1.3	1.2	0.9, 1.5	1.2	0.9, 1.7
Fair/poor	1.0	0.8, 1.3	0.9	0.7, 1.2	0.9	0.6, 1.5	0.8	0.4, 1.5	1.0	0.6, 1.6	1.2	1.0, 1.6	2.1	1.2, 3.7
p trend	0.94		0.26		0.83		0.64		0.74		0.08		0.01	
Cigarette smoking														
Never	1.0		1.0		1.0		1.0		1.0		1.0		1.0	
Former	1.2	0.9, 1.6	1.2	0.9, 1.5	0.8	0.6, 1.1	0.9	0.7, 1.3	1.2	0.9, 1.8	1.2	1.0, 1.6	0.6	0.3, 1.0
Current	0.9	0.7, 1.1	0.7	0.6, 1.0	0.6	0.4, 0.8	0.9	0.6, 1.2	0.4	0.3, 0.7	1.0	0.8, 1.3	0.6	0.4, 1.0
p trend	0.50		0.11		0.02		0.43		0.01		0.49		0.03	
Beer consumption														
Never	1.0		1.0		1.0		1.0		1.0		1.0		1.0	
1–4 times/month	0.9	0.7, 1.2	1.0	0.7, 1.4	0.8	0.6, 1.1	0.9	0.6, 1.3	0.7	0.5, 1.2	0.8	0.6, 1.1	0.7	0.4, 1.3
≥5 times/month	1.0	0.7, 1.2	1.1	0.8, 1.4	1.0	0.7, 1.4	1.2	0.8, 1.8	0.9	0.5, 1.6	1.0	0.7, 1.4	1.1	0.5, 2.2
p trend	0.28		0.73		0.65		0.61		0.60		0.88		0.95	
Wine consumption														
Never	1.0		1.0		1.0		1.0		1.0		1.0		1.0	
1–4 times/month	1.3	1.0, 1.8	1.1	0.8, 1.5	1.4	1.0, 2.0	1.5	1.0, 2.3	1.4	1.0, 2.0	1.2	0.9, 1.7	1.4	0.7, 2.7
≥5 times/month	1.7	1.2, 2.5	1.4	1.0, 1.8	1.8	1.2, 2.7	1.7	1.1, 2.3	1.2	0.7, 2.2	1.0	0.7, 1.5	1.1	0.5, 2.3
p trend	<0.01		0.01		<0.01		0.02		0.09		0.50		0.72	
Distilled spirits consumption														
Never	1.0		1.0		1.0		1.0		1.0		1.0		1.0	
1–4 times/month	0.8	0.6, 1.0	0.9	0.6, 1.2	0.6	0.3, 1.1	0.5	0.3, 1.0	0.9	0.5, 1.6	1.1	0.8, 1.6	0.9	0.4, 2.1
≥5 times/month	1.2	0.8, 1.7	1.4	1.0, 2.0	0.9	0.6, 1.5	1.1	0.7, 1.9	0.8	0.3, 2.5	1.4	0.9, 2.0	1.0	0.3, 3.1
p trend	0.98		0.26		0.36		0.83		0.56		0.12		0.95	

* Any dietary supplement and vitamin or mineral supplements with at least a 5% prevalence of usage and combined calcium supplements plus calcium-containing antacids not taken as dietary supplements.

† Refer to Appendix table 2 for supplement classification.

‡ All odds ratios were adjusted for all other characteristics included in the table.

§ OR, odds ratio; CI, confidence interval.

¶ Data for race/ethnicity categories Other and Other Hispanic not shown ($n = 435$) but are included in the total.

such excesses may be rare, the high prevalence of use, the availability of supplements with a high nutrient content, and the risk of multiple supplement use make this an area of concern.

Implications of findings for study design

A noteworthy finding of this study is that a larger part of the population ingests nondietary calcium as antacids than as calcium supplements, which highlights the importance of assessing calcium-containing antacid use in studies of calcium intake and health. Importantly, intake of calcium antacids is sometimes greater in population groups with lower calcium supplement use. For example, when antacids were included, obese people, current smokers, beer drinkers, and more frequent distilled spirit consumers were as likely as other population groups to take supplemental calcium. NHANES 1999–2000 data show that the most common amount of calcium was 500 mg (range, 106–600) in a calcium supplement and 200 mg (range, 112–500) in an antacid. Thus, although on average an antacid tablet may provide less calcium than a calcium supplement, and usage patterns may differ (e.g., antacids taken intermittently but perhaps several times per day vs. daily calcium supplement use), these data show that calcium-containing antacid intake is important to consider when assessing total calcium intake. Current interest in the associations of calcium intake with a variety of chronic diseases (22–28) underscores the importance of accurate total calcium intake assessment.

TABLE 4. Percent distribution and mean number of supplements* taken by US adult supplement users, by gender and age, National Health and Nutrition Examination Survey, United States, 1999–2000

Characteristic	No. of supplement users	No. of supplements taken (% (standard error))				Geometric mean (standard error)
		1	2	3	≥4	
Total	2,399	47.3 (1.3)	22.7 (1.1)	13.2 (0.9)	16.8 (1.3)	1.81 (0.04)
Gender						
Male	952	50.9 (1.9)	21.8 (1.7)	11.2 (1.2)	16.1 (2.0)	1.74 (0.06)
Female	1,447	44.6 (1.6)†	23.3 (1.4)	14.7 (1.3)	17.4 (1.3)	1.86 (0.04)‡
Age (years)						
20–39	746	60.3 (2.2)	20.8 (1.8)	11.1 (1.6)	7.9 (1.2)	1.49 (0.04)
40–59	653	41.9 (2.7)	25.0 (2.0)	14.2 (1.7)	18.8 (2.3)	1.94 (0.08)
≥60	1,000	36.9 (2.0)§	22.1 (1.4)	14.7 (1.6)	26.4 (2.0)	2.14 (0.07)¶

* Calcium-containing antacids not taken as dietary supplements were not included.
† $p < 0.01$, χ^2 test: only one supplement vs. more than one.
‡ $p = 0.06$, t test: mean number of supplements.
§ $p < 0.001$, χ^2 test: only one supplement by age group.
¶ $p < 0.001$, Wald F test of mean number of supplements.

The NHANES data collection procedure allows some examination of misreporting of dietary supplements. Despite instructions to report prescription supplements as dietary supplements, 204 of the 5,299 supplements taken by adults were recorded as prescription medicines, not supplements. Such omissions could contribute to underreporting in studies of supplement use. Conversely, some foods and drinks, particularly vitamin- and mineral-fortified ones, were reported as supplements. Despite the definition of supplements provided by the Dietary Supplement Health and

TABLE 5. Distribution of frequency (column %* (standard error)) of dietary supplement† use in the past month and number of months that dietary supplements were taken by US adults, by supplement type, National Health and Nutrition Examination Survey, United States, 1999–2000

	Multivitamin/ multimineral	B-complex vitamins	Vitamin C	Vitamin E	Calcium	Calcium/ antacids
Use in the past month‡						
1–4 times§	2.0 (0.5)	3.1 (1.8)¶	#3.2 (1.3)	0.4 (0.3)¶	2.8 (1.1)¶	19.1 (2.7)
5–29 times	6.1 (0.9)	13.4 (2.5)	6.9 (1.3)	5.9 (1.5)	6.8 (1.8)	11.2 (1.8)
30 times	84.9 (1.6)	77.7 (3.3)	82.1 (2.4)	89.7 (1.8)	70.0 (2.7)	47.2 (2.0)
>30 times	7.1 (1.1)	5.8 (2.0)	7.7 (1.4)	4.0 (1.2)	20.5 (2.9)	22.5 (2.2)
No. of months of use						
<1	6.0 (0.7)	4.5 (1.9)¶	6.9 (1.5)	3.9 (1.0)	4.2 (1.2)	4.1 (1.0)
1–5	20.7 (1.5)	17.2 (2.7)	15.4 (2.3)	11.3 (2.0)	15.6 (2.8)	12.5 (1.8)
6–11	10.7 (1.1)	5.6 (1.9)	7.4 (1.3)	9.6 (1.8)	10.5 (1.6)	6.8 (0.8)
12–23	15.2 (1.1)	19.3 (4.0)	14.8 (2.5)	14.2 (2.0)	15.7 (2.0)	14.1 (1.7)
24–59	22.2 (1.3)	23.3 (3.3)	17.8 (2.1)	26.7 (2.4)	28.9 (3.3)	25.5 (2.0)
60–119	10.9 (1.1)	12.2 (3.0)	9.0 (1.7)	12.4 (1.8)	12.9 (2.8)	12.8 (1.9)
≥120	14.3 (1.4)	17.9 (3.6)	28.7 (2.8)	21.9 (2.0)	12.3 (1.7)	24.3 (1.7)

* Percentage based on those using the supplement type.
† Any dietary supplement and vitamin or mineral supplements with at least a 5% prevalence of usage and combined calcium supplements plus calcium-containing antacids not taken as dietary supplements; refer to Appendix table 2 for supplement classification.
‡ Excludes supplements with a reported frequency of "frequency varied"; if more than one supplement of the same type was reported, the reported frequencies were summed.
§ Equivalent to once per week or less, more than once per week but less than daily, daily, and more than daily.
¶ Estimate does not meet the minimum standard of statistical reliability (relative standard error >30%).

Education Act (1) and additional depiction by the US Food and Drug Administration (29), the line between supplements and foods or drinks seems unclear and may be a source of over- or underreporting of supplement use in surveys. For surveys that cannot collect data in as much detail as NHANES can, it may help reduce such misreporting to instruct participants to include prescription supplements and exclude sports and other fortified drinks and foods or, if time permits, to ask about these separately, before supplements.

Implications of findings for study analysis

Because these data come from a survey that yields a nationally representative sample and calculates respondent sampling weights to account for nonresponse and other selection factors, the results provide estimates of dietary supplement use in the past month for the total US civilian noninstitutionalized population and by various demographic and lifestyle characteristics. The associations observed can be used to inform the design, analysis, and interpretation of nonrepresentative studies of supplement use. For example, for the most commonly used supplements and for any supplement use, bivariate results (tables 1 and 2) show that older age, higher educational level, physical activity, race/ethnicity, and never smoking were associated with higher use of all of these supplement types, while other lifestyle/demographic characteristics were associated with only some supplement types. With multivariable control (table 3), some associations were no longer evident, such as those of race/ethnicity with B-complex vitamins and calcium, smoking with all supplement types except vitamin E and calcium, and physical exercise with vitamin C. These findings suggest that the prevalence rates for specific supplements from nonrepresentative populations could be biased differentially for different supplement types as well as for total supplement use.

Additionally, the associations found between supplement use and demographic/lifestyle characteristics stress the difficulty in interpreting results of observational studies of these characteristics or of dietary supplement use with health. Statistical associations between health conditions and supplement use or demographic/lifestyle characteristics may result from confounding rather than reflect a true biologic association. The high prevalence of supplement use and the strength of some of the associations with demographic/lifestyle variables seen in our analyses suggest including all of these variables in studies of nutrient intake, demographics, and lifestyle with health.

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APPENDIX TABLE 1. Card of examples of dietary supplements shown to National Health and Nutrition Examination Survey participants, United States, 1999–2000

ANTACIDS TAKEN AS A CALCIUM SUPPLEMENT	Tums Antacid/Calcium Supplement™, Tums E-X Antacid/Calcium Supplement™
BOTANICALS, HERBS, AND HERBAL MEDICINE PRODUCTS	Echinacea, ginseng, gingko, St. John's Wort, kava kava, dong quai, saw palmetto
FIBER TAKEN AS A DIETARY SUPPLEMENT	Fiberwafers™, Florafiber™, Herb-lax™, Psyllium™, Metamucil™, Fibercon™
INDIVIDUAL OR SINGLE VITAMINS	Vitamin A, vitamin C, or vitamin E
MULTIPLE VITAMINS (2 OR MORE COMBINED)	B complex, Centrum™, Flintstones™, vitamins C and E
INDIVIDUAL OR SINGLE MINERALS	Calcium, copper, iron, or zinc
MULTIPLE MINERALS (2 OR MORE COMBINED)	Iron and zinc, or calcium and magnesium
VITAMIN AND MINERAL COMBINATIONS	Centrum™ with minerals, Flintstones with iron™, calcium plus Vitamin D
COMBINATIONS OF VITAMINS, MINERALS AND OTHER PRODUCTS	One-a-Day™ with Gingko
AMINO ACIDS	Lysine, methionine, and tryptophan
FISH OILS	Omega–3 fatty acids
GLANDULARS	Pancreas, liver, and organ extracts
ZINC LOZENGES	Coldeeze™

Include products formulated to improve athletic performance, muscle strength, memory, increase energy, etc.

APPENDIX TABLE 2. Categorization of dietary supplements by National Health and Nutrition Examination Survey nutritionists, United States, 1999–2000*

Category	Description	Examples
Any	All categories of dietary supplements.	Vitamins, minerals, botanicals, amino acids, enzymes
Multivitamin/ multimineral†	Three or more vitamins with or without minerals; names do not refer to a specific vitamin or mineral.	Centrum™, One-A-Day™ antioxidant formula, Ocuvite™, Prenate™, vitamins for the hair
B-complex	Three or more B vitamins.	B-complex with vitamin C, balanced B-100, Stresstabs™, Nephro-vite™, Neurobion™
Vitamin or mineral supplement	Specifically named single vitamins or minerals; may also contain other ingredients.	Vitamin C with rosehips, iron with folic acid, brewer's yeast (B_{12}), cod liver oil (vitamin A with D), calcium with vitamin D
Multimineral	More than two minerals; no vitamins.	Colloidal minerals, trace minerals
Combined calcium/ antacid	Calcium supplements or calcium-containing antacids, whether recorded as supplements or antacids.	Antacids: Tums™, Rolaids™, Alka-Mints™; calcium supplements: Citrical™, Oscal™, Caltrate™, calcium with magnesium and zinc

* Further details are available from the first author on request.

† Two percent of these products were multiple vitamins with no minerals.