

Vitamin and Mineral Supplement Use in the United States

Results From the Third National Health and Nutrition Examination Survey

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Context: The use of supplements remains a widespread behavior among people motivated by general health concerns. We analyzed data from the third National Health and Nutrition Examination Survey (NHANES III) to provide new and current information on supplement use in the United States.

Objectives: To determine the prevalence of vitamin and mineral supplement use in the US population, to quantify the use of folic acid, and to examine the relationship between supplement intake and demographic factors.

Design: National, population-based, cross-sectional survey of monthly use of vitamin and mineral supplements by NHANES III participants (n = 33 905).

Results: More than 11 000 respondents reported taking at least 1 vitamin or mineral supplement at any time in the past month. The highest use of vitamin and mineral supplements was among non-Hispanic whites (42.6%), with a mean age of 37 years. Approximately 29.2% of people in the United States, and 33.2% of women

of reproductive age, reported taking at least 1 product that contained folic acid any time in the past month. The use of products containing folic acid was highest among non-Hispanic whites (32.1%), and 62.1% of all those taking folic acid (71.5% among females of reproductive age) took at least 12 000 µg/mo (equivalent to the recommended daily dose of 400 µg/d). Participants reported using more than 300 nonvitamin and nonmineral products, some of which are documented as having serious adverse health effects.

Conclusions: Consumption of vitamin and mineral supplements is a common behavior in the United States. We recommend that physicians and health professionals include questions about the use of dietary supplements when obtaining a medical history from their patients, that all dietary supplements clearly list ingredients and known contraindications to use, and that all those planning to use supplements first have their dietary practices and lifestyle evaluated by a health professional.

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ALTHOUGH DIETARY sources have long been thought to provide adequate nutrients, the use of vitamin and mineral products to supplement the diet is a common health practice for millions of Americans.¹ As much as \$1.3 to \$1.7 billion are spent annually on vitamin and mineral supplements in the United States, making these the third largest over-the-counter drug category used.²⁻⁴

Although use of dietary supplements is increasing in popularity, patterns of use of these supplements are not well known. People have reported a variety of reasons for taking dietary supplements, including decreasing their susceptibility to health problems such as stress, colds, heart attacks, and cancer, and increasing their energy.⁵⁻⁷ Coinciding with this trend is the appearance in scientific

literature of evidence to support supplementation with some vitamins. For example, scientists have established that folic acid has beneficial health effects in doses not usually achieved by consuming a typical diet, and supplementation with 400 µg/d of folic acid has been recommended by the US Public Health Service for all women of childbearing age capable of becoming pregnant to prevent neural tube defects. Nevertheless, the relationship between health status and supplement use remains unclear for most dietary supplements.

We used data from the third National Health and Nutrition Examination Survey (NHANES III, 1988-1994) to determine the prevalence of vitamin and mineral supplement use in the US population, to quantify the use of folic acid, and to examine the relationship between dietary intake of supplements and various demographic factors.

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MATERIALS AND METHODS

NHANES III SAMPLE DESIGN

The NHANES III, conducted by the National Center for Health Statistics of the Centers for Disease Control and Prevention, Atlanta, Ga, used a stratified, multistage probability design. The sample was chosen to be representative of the total noninstitutionalized population of those people at least 2 months of age in the United States. Sampling weights were used with the NHANES III data to produce population estimates. Data were collected in two 3-year survey periods, phases I (1988 to 1991) and II (1991-1994).

MEASURES OF VITAMIN AND MINERAL SUPPLEMENT USE

A *dietary supplement* is defined by the Dietary Supplement Health and Education Act of 1994 as "a product (other than tobacco) intended to supplement the diet that bears or contains one or more of the following dietary ingredients: a vitamin, a mineral, an herb or other botanical, an amino acid, or a dietary substance for use by man to supplement the diet by increasing the total dietary intake, or a concentrate, metabolite, constituent, extract, or combination of the above ingredients."⁸ Participants in the NHANES III were questioned specifically about their use of vitamin and mineral supplements, although some respondents reported using other dietary supplements.

Data on vitamin and mineral supplement use were collected through household interviews. Study participants were asked whether they had taken any vitamin or mineral supplements in the past month. A proxy responded for participants younger than 17 years. If participants reported using a vitamin or mineral supplement in the past month, they were further questioned about the number of supplements used, the name of the product(s), how often they used each product, how much of the product they consumed, and how long they had been taking the product.

SOCIODEMOGRAPHIC VARIABLES

Age at the time of the household interview was categorized as follows: 2 to 11 months and 1 to 2, 3 to 5, 6 to 11,

12 to 19, 20 to 29, 30 to 39, 40 to 49, 50 to 59, 60 to 69, and 70 years and older. These categories are consistent with the NHANES III survey design.⁹

Race/ethnicity was classified in NHANES III as non-Hispanic white, non-Hispanic black, Mexican American, or other. These categories are mutually exclusive. The category of "other" was too small to be analyzed separately but was included in all totals.⁹

The poverty-income ratio (PIR) was defined as the total family income divided by the poverty threshold, as determined by the US Bureau of the Census, for the year of the interview.⁹ To be consistent with major government food assistance programs that use a PIR cutoff of 1.3 to determine eligibility, PIR categories used in analyses were low (≤ 1.3), middle ($>1.3-3.5$), and high (>3.5).

Education was classified as 0 to 8, 9 to 11, 12, and 13 or more years.

Region was classified as Northeast, Midwest, South, or West, as defined by the census.

ANALYTIC SAMPLE

The household questionnaires (adult and youth) were administered to 33 994 people, and we limited our analysis sample to the 33 905 people who responded yes or no when asked whether they had taken any vitamin or mineral supplements in the past month. People who did not respond to the question or who responded don't know ($n = 89$) were not included in the analysis.

DATA ANALYSIS

All prevalence estimates were derived using SUDAAN, a statistical package compatible with SAS (SAS Institute Inc, Cary, NC) that accounts for the complex survey design and weights.¹⁰

We calculated estimates of the monthly consumption of folic acid by multiplying the amount of folic acid in each product (in micrograms) by the self-reported frequency of use and the dosage. When data for any of those variables were missing from any participant's record, we excluded that record from the analysis of folic acid consumption.

RESULTS

More than 11 000 respondents in the NHANES III sample reported taking at least 1 vitamin or mineral supplement any time in the past month. This number is equivalent to approximately 40% of the US population. These supplements were divided into 7 classes, as seen in the following tabulation:

Class	No. of Products
Vitamin-mineral combination	736
Vitamin-single nutrient combination	522
Vitamin-multiple nutrient combination	377
Mineral-single nutrient combination	307
Mineral-multiple nutrient combination	73
Other dietary supplement with vitamins or minerals	102
Other dietary supplement	311
All	2428

The 2 classes with the largest number of products reported are the vitamin-mineral and vitamin-single nutrient combinations.

The 10 most common ingredients and the percentages of products containing those ingredients are given in the following tabulation:

Ingredient	Products Containing Ingredient, %
Ascorbic acid (vitamin C)	45.0
Cyanocobalamin (vitamin B ₁₂)	39.3
Pyridoxine hydrochloride (vitamin B ₆)	39.1
Nicotinic acid (niacin)	39.0
Thiamin	38.0
Riboflavin (vitamin B ₂)	37.7
Vitamin E	37.1
Beta carotene (vitamin A)	37.0
Cholecalciferol (vitamin D)	34.0
Folic acid	34.0

Table 1. Supplement Use by Age, Sex, and Race/Ethnicity in the NHANES III*

Age	Non-Hispanic White		Non-Hispanic Black		Mexican American		All†	
	Male	Female	Male	Female	Male	Female	Male	Female
2-11 mo	29.6 (2.7)	25.0 (2.4)	19.8 (4.2)	15.5 (3.8)	23.6 (4.8)	27.9 (4.6)	27.6 (2.1)	25.3 (1.7)
1-2 y	46.9 (2.4)	45.7 (3.0)	33.3 (2.7)	30.7 (3.1)	36.8 (2.0)	40.4 (2.4)	43.3 (1.6)	42.0 (2.2)
3-5 y	57.6 (4.4)	51.6 (3.1)	30.3 (2.5)	32.7 (2.3)	36.8 (2.7)	39.8 (2.9)	51.0 (3.3)	45.8 (2.0)
6-11 y	38.6 (3.2)	36.2 (3.1)	23.9 (1.7)	24.6 (2.2)	27.3 (4.3)	26.1 (3.4)	35.4 (2.2)	33.5 (2.4)
12-19 y	26.7 (3.2)	29.5 (3.2)	16.0 (2.0)	19.9 (2.0)	17.5 (1.6)	21.9 (2.2)	23.9 (2.3)	28.0 (2.2)
20-29 y	33.3 (2.9)	46.8 (2.8)	24.1 (1.9)	31.0 (2.6)	18.6 (2.4)	31.5 (1.9)	29.7 (2.1)	41.8 (1.9)
30-30 y	35.6 (2.5)	50.0 (2.4)	31.2 (2.2)	36.6 (1.8)	27.8 (2.6)	33.3 (1.5)	34.1 (2.1)	45.8 (1.9)
40-49 y	37.3 (3.2)	49.0 (3.3)	30.5 (2.9)	38.3 (2.7)	28.5 (2.5)	34.1 (2.8)	35.4 (2.6)	47.0 (2.8)
50-59 y	41.4 (2.5)	55.1 (2.3)	31.0 (3.1)	41.0 (2.7)	34.7 (3.4)	41.7 (4.1)	40.4 (2.2)	51.7 (2.0)
60-69 y	40.9 (1.9)	52.8 (2.5)	29.4 (2.7)	42.1 (2.6)	33.8 (2.9)	42.2 (3.0)	39.3 (1.8)	51.6 (2.1)
≥70 y	40.8 (2.1)	56.1 (2.1)	31.2 (2.8)	42.4 (3.4)	38.4 (6.5)	48.8 (4.7)	40.5 (2.0)	54.4 (2.0)

*Data are given as percentage (SE of the percentage). NHANES III indicates third National Health and Nutrition Examination Survey.

†Includes respondents of the "other" category.

Table 2. Supplement Use by Demographics in the NHANES III*

Demographic Variable	Supplement Use, %	χ^2 P
Sex		
Male	34.9] <.001
Female	43.8	
Race/ethnicity		
Non-Hispanic white	42.6] <.001
Non-Hispanic black	29.8	
Mexican American	29.0	
Income level†		
Low	28.6] <.001
Medium	38.9	
High	49.4	
Region		
Northeast	37.8] .002
Midwest	38.0	
South	36.2	
West	47.8	
Education, y‡		
0-8	30.7] <.001
9-11	32.8	
12	38.5	
≥13	49.9	

*NHANES III indicates third National Health and Nutrition Examination Survey.

†Levels are described in the "Sociodemographic Variables" subsection of the "Materials and Methods" section.

‡Limited to adults aged 17 years or older.

Table 1 and **Table 2** show the distribution of vitamin and mineral supplement use by selected age, sex, and race/ethnicity. The highest use was among non-Hispanic whites (42.6%). In general, adult non-Hispanic white females consumed the most vitamin and mineral supplements. Of those taking vitamin and mineral supplements, 43% were male and 57% were female; the mean age of those taking vitamin and mineral supplements was 37 years. In general, the use of vitamin and mineral supplements among non-Hispanic black and Mexican American females tended to increase slightly with age, whereas people with more than 12 years of education were more likely to

use vitamin and mineral supplements than were those with less education. Those with middle or high incomes tended to use vitamin and mineral supplements more than those with low incomes, and people living in the West were more likely to report vitamin and mineral supplement use (47.8%) than were people living in other regions.

Folic acid was listed as an ingredient in 818 of the vitamin and mineral supplement products reported in NHANES III. Approximately 29% of people in the United States, and 33.2% of women of reproductive age (aged 15-45 years) reported taking at least 1 product that contained folic acid any time in the past month. The use of products containing folic acid was highest among non-Hispanic whites (32.1%), followed by non-Hispanic black (20.3%) and Mexican Americans (19.5%). The use of folic acid products was less common among persons with low incomes and more common among women, people aged 20 to 49 years, and those with more than 12 years of education. When we excluded pregnant women and limited the analysis to subjects aged at least 12 years, our findings were similar. After excluding those records lacking dosage data, we estimated the monthly consumption of folic acid. The recommended daily dose of folic acid is 400 µg/d. We found that 62.1% of all folic acid users (67.0% of women and 55.6% of men) were taking at least 12 000 µg/mo (equivalent to 400 µg/d) of folic acid. Among women of reproductive age, approximately 71.5% of those taking folic acid were taking at least 12 000 µg/mo. National estimates of folic acid use obtained from both survey periods (ie, before and after the Public Health Service recommendation of 1992) were similar. During phase I, 61.0% of those taking folic acid were taking at least the recommended amount compared with 63.1% who took the supplement during phase II.

Although the survey did not ask about unusual dietary supplements, some participants volunteered information on these products. The information provided was insufficient to estimate national use of these products; however, more than 300 nonvitamin–nonmineral products were reported. The following

tabulation lists the primary toxic effects of the most common of these products:

Common Name	Toxic Effects
Black cohosh	Nervous system disturbance, nausea, dizziness
Chaparral	Hepatic dysfunction and hepatotoxic effects
L-Tryptophan	Eosinophilia myalgia, sclerodermiform skin changes
Thyroid	Severe hypotension, abdominal distress, central nervous system paralysis
Yohimbine	Nervousness, emotional instability, excessive sweating, intolerance, hyperkinesia

COMMENT

Certain dietary supplements, such as those containing vitamins and minerals, may be important sources of total nutrients. In our analysis, we found that the 2 classes with the largest number of products were vitamin–single nutrient and vitamin–mineral combinations. Products in these classes are designed to increase the dietary intake of 1 or more essential nutrients. These products may become increasingly important in vitamin and mineral supplementation, since dietary practices in the United States have changed in ways that have reduced the vitamin delivery from the diet.¹¹ For example, consumption of processed foods has increased, and many meals, including snacks, are eaten away from home.¹² However, people need to be aware that excessive use of vitamin–mineral supplements may produce undesirable effects. Dietary supplements are typically used without medical supervision, and specific indications for use of supplements are usually lacking. Users of dietary supplements may combine 2 or more products and set their own dosage regimen without anticipating potential adverse effects, including overdose.¹³

Vitamin C was the most common ingredient mentioned in the products listed in NHANES III. Vitamin C helps detoxify harmful substances in the liver; assists in maintaining healthy teeth, bones, and blood vessels; and is typically considered to be an essential nutrient and one with few adverse effects.¹⁴ On the other hand, large doses of some vitamins, such as beta carotene (vitamin A), are known to be teratogenic.^{15,16} In NHANES III, 3% of those taking beta carotene were taking potentially teratogenic amounts ($\geq 600\,000$ IU/mo). Therefore, before people use any vitamin or mineral supplement, they should be carefully evaluated for the adequacy of their dietary intake, unusual dietary practices, and specific lifestyle issues, such as vegetarianism or weight reduction diets.¹²

In our analysis, the demographic and socioeconomic pattern of vitamin and mineral supplement use was similar to that found in NHANES II.¹⁷ We also found that use of vitamin–mineral supplements was more common among white female respondents and among those with higher incomes and education, a finding common to other studies.^{1,17–20}

To our knowledge, little documentation exists in the literature to quantify the use of vitamin or mineral supplements. Therefore, in our analysis, we decided to quantify the use of folic acid, an important vitamin for women of reproductive age. The data indicate that the use of products containing folic acid is more common

among non-Hispanic whites, older people, and those with more education. In 1992, the US Public Health Service recommended that all adolescent girls and women of childbearing age who are capable of becoming pregnant consume 400 $\mu\text{g}/\text{d}$ of folic acid.²¹ Approximately 33.2% of women of reproductive age reported taking at least 1 product containing folic acid any time in the past 30 days. Of those women, 71.5% met the Public Health Service's recommendation by consuming at least 12 000 $\mu\text{g}/\text{mo}$ of folic acid. However, the finding that approximately 66.8% of adolescent girls and women of reproductive age may not be taking products containing folic acid is of concern, in view of the fact that use of folic acid is one of the most effective means of preventing birth defects currently known. Therefore, our findings imply that additional efforts are needed to increase the use of folic acid by girls and women of reproductive age.

Although the information on unusual dietary supplement products that was volunteered by some participants cannot be used to quantify actual products use or to make any national estimates of use, such use suggests that people take a variety of unorthodox supplements, and that further study to determine the frequency, popularity, and specific products used could prove valuable. Supplement users may combine 2 or more products and may set their own dosage, which can cause serious health effects. Many of the products reported, such as black cohosh, chaparral, L-tryptophan, thyroid, and yohimbine, are documented to have serious adverse health effects.²² Other products mentioned, such as anabolic vasotone and sterol complex, may represent potential hazards as well.

Consumption of vitamin and mineral supplements is a common behavior in the United States. Health professionals, however, may be unaware of the popularity of dietary supplements among their patients. Health professionals should be alert to the potential health effects from overdosing or underdosing by those using the supplements. We recommend that physicians and health professionals include questions about the use of dietary supplements when obtaining a medical history from their patients, that all dietary supplements clearly list ingredients and known contraindications to use, and that those planning to use supplements should have their dietary practices and lifestyle evaluated by a health professional before using any dietary supplements.

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Clinical Pearl

Group Therapy for Somatization

In a randomized trial, somatization disorder patients who attended group therapy had better physical and mental health at 1 year. In general, the more sessions attended, the better the health improvement. Medical care costs dropped in 1/2. (*Psychosomatics*. 1995;36:462-470.)

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Correction

Errors in Text. In the original contribution by Balluz et al titled "Vitamin and Mineral Supplement Use in the United States: Results From the Third National Health and Nutrition Examination Survey," published in the March issue of the ARCHIVES (2000;9:258-262), the following errors regarding ingredient names occurred in the text. On page 259, the second tabulation in the "Results" section should have appeared as follows:

Ingredient	Products Containing Ingredient, %
Vitamin C	45.0
Vitamin B ₁₂	39.3
Vitamin B ₆	39.1
Niacin	39.0
Thiamin	38.0
Riboflavin	37.7
Vitamin E	37.1
Vitamin A	37.0
Vitamin D	34.0
Folic acid	34.0

On page 261, at the top of the page, the common name of the last item in the tabulation should have appeared as "Yohimbe." In the "Comment" section on that same page, the third and fourth sentences of the second paragraph should have read as follows: "On the other hand, large doses of some vitamins, such as vitamin A (retinol), are known to be teratogenic.^{15,16} In NHANES III, 3% of those who reported taking vitamin A might be taking potentially teratogenic amounts ($\geq 600\,000$ IU/mo)." In the fifth paragraph of the "Comment" section, the third sentence should have read as follows: "Many of the products reported, such as black cohosh, chaparral, L-tryptophan, thyroid, and yohimbe, are documented to have serious adverse health effects.²²" The journal regrets the errors.