American Journal of Epidemiology

Vol. 157, No. 10
*Printed in U.S.A.*
DOI: 10.1093/aje/kwg072

# Factors Associated with Dietary Supplement Use among Healthy Adults of Five Ethnicities

## The Multiethnic Cohort Study

**Janet A. Foote[1], Suzanne P. Murphy[1], Lynne R. Wilkens[1], Jean H. Hankin[1], Brian E. Henderson[2], and Laurence N. Kolonel[1]**

[1] Cancer Research Center of Hawaii, University of Hawaii, Honolulu, HI.
[2] Keck School of Medicine, University of Southern California, Los Angeles, CA.

*Received for publication June 25, 2002; accepted for publication November 27, 2002.*

Participants of the Multiethnic Cohort Study in Hawaii and Los Angeles, California, a representative sample of African-American, Native Hawaiian, Latino, Japanese-American, and White adults, completed a baseline questionnaire in 1993–1996 assessing dietary supplement use during the past year as well as demographic, dietary, and other lifestyle factors. Factors associated with supplement use were examined among those who reported an absence of chronic disease ($n$ = 100,196). Use of any of eight supplements at least once per week during the past year ranged from 44% among Hawaiian men to 75% among Japanese-American and White women. Multivitamins were the most frequently reported supplement; 48% of the men and 56% of the women reported regular use. Dietary supplement use was high across all ethnic groups, although levels and length of regular use varied. In all gender-specific ethnic groups, supplement use tended to increase with age, education, physical activity, fruit intake, and dietary fiber intake and to decrease with obesity, smoking, and dietary fat intake. Participants whose lifestyles were healthier were more likely to use dietary supplements. Therefore, it may be difficult to separate the effects of supplement use from other lifestyle factors when studying disease etiology.

adult; aged; cohort studies; dietary supplements; ethnic groups; health; minerals; vitamins

Abbreviation: NHANES III, Third National Health and Nutrition Examination Survey.

The dietary supplement market is reported to be one of the world's fastest growing industries (1). The Third National Health and Nutrition Examination Survey (NHANES III) found that 35–55 percent of US men and women aged 30 years or older reported use of dietary supplements within the past month (2). The authors suggested that awareness of studies that link specific dietary nutrients with lower disease risk may affect the public's attitudes toward and the use of dietary supplements. Furthermore, the Dietary Reference Intakes recommend that intake of vitamin $B_{12}$ by older adults who may be at risk of poor absorption and of folate for women capable of becoming pregnant should be from supplemental or fortified sources (3). A modified food guide pyramid for persons older than 70 years of age recommends supplemental intake of both vitamin $B_{12}$ and calcium (4). These recommendations underscore the necessity of including supplemental sources of intake in any investigation of nutrient and disease associations.

The numerous formulations of dietary supplements available present assessment and analytic challenges (5–7). Despite variations in the composition of supplemental products, reported characteristics of supplement users have been fairly consistent. Several studies have examined lifestyle and demographic associations with dietary supplement use, finding greater use among women, older adults, and those whose levels of education or socioeconomic status are higher (8, 9). NHANES III and previous US national surveys reported higher levels of supplement use among Whites compared with non-Hispanic Blacks and Hispanic adults (2, 7). Dietary differences including lower fat consumption and higher fiber intake have been found among dietary supplement users compared with nonusers (10, 11). Thus, supple-

Reprint requests to Dr. Janet Foote, Cancer Research Center of Hawaii, University of Hawaii, 1236 Lauhala Street, Suite 406E, Honolulu, HI 96813 (e-mail: jfoote@crch.hawaii.edu).

ment use is associated with a variety of demographic and lifestyle factors.

However, most previous studies asked about current use only and were not aimed at minimizing the influence that preexisting chronic disease may have on supplement use. Because supplement use may be different among those with chronic diseases (10, 11), it is more informative to examine use by healthy adults separately. It is also unclear whether the extent of dietary supplement use differs among ethnic groups, especially those who have not been well represented in national surveys. To address these issues, we analyzed information on dietary supplement use among healthy adult participants in the Hawaii–Los Angeles Multiethnic Cohort, a large study of five ethnic groups (12). We also examined the influence of demographic, lifestyle, and dietary factors on supplement use.

## MATERIALS AND METHODS

### Multiethnic cohort

The Hawaii–Los Angeles Multiethnic Cohort is a prospective cohort study designed to examine the relation of diet and other risk factors with cancer among representative population groups of five ethnicities: Japanese American, Native Hawaiian, and non-Hispanic White (recruited primarily in Hawaii); and African American and Latino (recruited primarily from the greater Los Angeles, California, area) (12). To achieve as representative a sample of these ethnic groups as possible, driver's license files were used as a primary sampling source since most adults in these areas have driver's licenses. To augment this source, the voter registration file was used in Hawaii, and the Health Care Financing Administration (now known as Centers for Medicare and Medicaid Services) files and census tract information of Los Angeles County were used in the Los Angeles area. On the basis of a comparison of Multiethnic Cohort participants with the 1990 US Census regarding selected variables, the Multiethnic Cohort sample appeared to be well representative of the five ethnic populations in the study areas (12). Quantified 3-day measured food records were used to develop a single, self-administered questionnaire appropriate for all ethnic groups (12, 13). The mailed questionnaire was developed in English and was translated (including back-translation) into Spanish for potential Latino participants, who were offered both the English and Spanish versions from which to choose. Approximately 39 percent of the Latinos completed the Spanish version of the questionnaire (9 percent of the overall cohort). Baseline information was collected during 1993–1996 for approximately 215,000 adults aged 45–75 years. The design and characteristics of the Multiethnic Cohort population have been described previously (12, 13).

### Baseline questionnaire

The baseline questionnaire included various demographic, lifestyle, and medical history items, including migrant status, gender, height, weight, date of birth, education, smoking, sun exposure, physical activity, prior illness, and use of medications. Age group designation was based on the age of the participant at completion of the baseline questionnaire (questionnaire date minus date of birth). Height and weight information was used to determine body mass index (weight in kilograms/height in meters squared), which was categorized as normal (less than 25), overweight (25–<30), or obese (30 or more) (14). Regular smokers were defined as subjects reporting lifetime use of 20 or more packs of cigarettes. Assessment of physical activity was based on the person's response regarding the average number of times per week that he or she participated in vigorous physical activity long enough to work up a sweat.

Included in the baseline questionnaire was a quantitative food frequency questionnaire. A subsequent calibration study found correlations ranging from 0.55 to 0.74 between energy-adjusted daily nutrient estimates from the quantitative food frequency questionnaire and nutrient estimates derived from three 24-hour recalls among a random, ethnically diverse subsample of the Multiethnic Cohort (13). We used gender-specific quartiles of several dietary variables from the quantitative food frequency questionnaire to examine associations with supplement use: daily proportion of energy consumed as fat, and grams of dietary fiber, fruit, vegetables, and alcohol.

### Sample size

Of the 215,902 Multiethnic Cohort participants, 11,812 (5 percent) did not self-identify as one of the five primary ethnic groups for which the study was designed to be representative and thus were excluded from the current analysis. The aim of this analysis was to examine associations with supplement use among basically healthy persons, because those with major chronic disease may take supplements therapeutically. For instance, cohort members reporting a history of cancer were significantly more likely to use supplements (odds ratio = 1.22, 95 percent confidence interval: 1.18, 1.27). Therefore, participants who reported a history of risk factors for cardiovascular disease (high blood pressure, heart attack or angina, diabetes, or stroke) or a history of cancer (except nonmelanoma skin cancer) were excluded. Approximately 39 percent of the exclusions were due to a reported history of high blood pressure. After exclusions, analyses were performed for 100,196 participants. Some individual models had slightly smaller sample sizes if information for any variable was not complete.

### Assessment of supplement use

One page of the baseline questionnaire was devoted to regular supplement use. For each of the following items, participants were asked to respond yes or no to whether they used this supplement at least once a week during the past year: multivitamins or multivitamins with minerals, vitamin A, vitamin C, vitamin E, beta-carotene, calcium, selenium, or iron. If the answer was affirmative, the participant was asked to select the frequency category describing how many tablets were taken: one to three per week, four to six per week, one a day, two a day, or three or more a day. Length of supplementation was requested for each supplement for

**TABLE 1. Distribution of characteristics (%) of the participant sample, Hawaii–Los Angeles Multiethnic Cohort Study, United States, baseline assessment 1993–1996**

| | African Americans (*n* = 12,018) | Native Hawaiians (*n* = 6,478) | Latinos (*n* = 24,510) | Japanese Americans (*n* = 28,354) | Whites (*n* = 28,836) | All (*n* = 100,196) |
|---|---|---|---|---|---|---|
| Gender | | | | | | |
| Male | 36.8 | 41.3 | 48.0 | 43.4 | 44.6 | 43.9 |
| Female | 63.2 | 58.7 | 52.0 | 56.6 | 55.4 | 56.1 |
| Age group (years)* | | | | | | |
| 45–<55 | 39.1 | 59.0 | 32.8 | 36.6 | 46.6 | 40.3 |
| 55–<65 | 27.7 | 25.6 | 45.0 | 29.7 | 29.5 | 32.9 |
| 65–75 | 33.2 | 15.4 | 22.1 | 33.7 | 23.9 | 26.8 |
| Educational level* | | | | | | |
| ≤12th grade | 36.3 | 47.7 | 67.2 | 35.6 | 23.1 | 40.4 |
| Post-high school/vocational | 38.4 | 31.7 | 21.9 | 30.3 | 31.5 | 29.7 |
| ≥College graduate | 25.3 | 20.6 | 10.9 | 34.2 | 45.4 | 29.9 |
| Body mass index (kg/m$^2$)* | | | | | | |
| Normal | 42.9 | 40.1 | 40.1 | 73.0 | 58.4 | 54.9 |
| Overweight | 39.0 | 37.1 | 44.2 | 23.8 | 31.2 | 33.6 |
| Obese | 18.1 | 22.8 | 15.7 | 3.2 | 10.4 | 11.5 |
| Smoking status* | | | | | | |
| Never | 37.7 | 38.9 | 51.5 | 52.0 | 40.6 | 45.9 |
| Former | 37.4 | 33.8 | 33.0 | 33.9 | 41.8 | 36.5 |
| Current | 24.8 | 27.3 | 15.5 | 14.1 | 17.5 | 17.6 |
| Physical activity (resulting in sweat)* | | | | | | |
| Never | 26.3 | 16.8 | 27.9 | 29.5 | 21.4 | 25.5 |
| 1–2 times/week | 26.2 | 27.5 | 26.1 | 33.9 | 29.4 | 29.4 |
| ≥3 times/week | 47.5 | 55.6 | 46.0 | 36.6 | 49.2 | 45.1 |

* Proportions within each ethnicity were adjusted for gender by poststratification.

which the participant reported use: 1 year or less, 2–4 years, or 5 years or more. Additionally, participants were asked to select the category representing the dose per tablet regarding intake of each supplement except multivitamins. For a representative subsample of the cohort, we compared supplement-use responses from the baseline questionnaire with those from three random 24-hour recalls that trained dietitians administered by telephone. For seven of the eight supplements, kappa statistics for any use ranged from 0.40 to 0.72; for vitamin A, agreement was poor at 0.17 (15). When the average of the three telephone recalls was used as a reference, 80 percent of the questionnaire values were within one category of the six frequency-of-use categories for each of the eight supplement products (15).

### Analyses

Descriptive analyses were conducted by using SAS software, version 6.12 (16). Because of an unbalanced gender distribution within ethnic groups, we adjusted demographic and lifestyle characteristics for gender in the results. Similarly, dietary supplement use within each ethnic group was adjusted for age. The gender and age adjustments were completed by using the poststratification method described by Rossi et al. (17), weighted by the proportion of the cohort of 100,196 in the gender-age groups. Differences in proportions were assessed by using the chi-square test. Stepwise elimination logistic regression for models of supplement use was conducted by using Stata statistical software, version 6.0 (18). A two-step process was used to determine the best models of dietary supplement use within each gender-specific ethnic group. Initially, demographic and lifestyle factors were examined for their association with supplement use. In the second step, dietary factors were assessed for their association with dietary supplement use in each gender-specific ethnic group after we controlled for the significant demographic and lifestyle factors. Final adjusted odds ratios and the corresponding 95 percent confidence intervals were determined from the best-fitting models of supplement use. Two-way interactions and fit of the models were assessed via likelihood ratio tests. The "lroc" procedure in Stata software was used to graph the specificity against one minus the sensitivity to produce the receiver operating characteristic curve. The area under the curve summarized the amount of supplement use explained by the model.

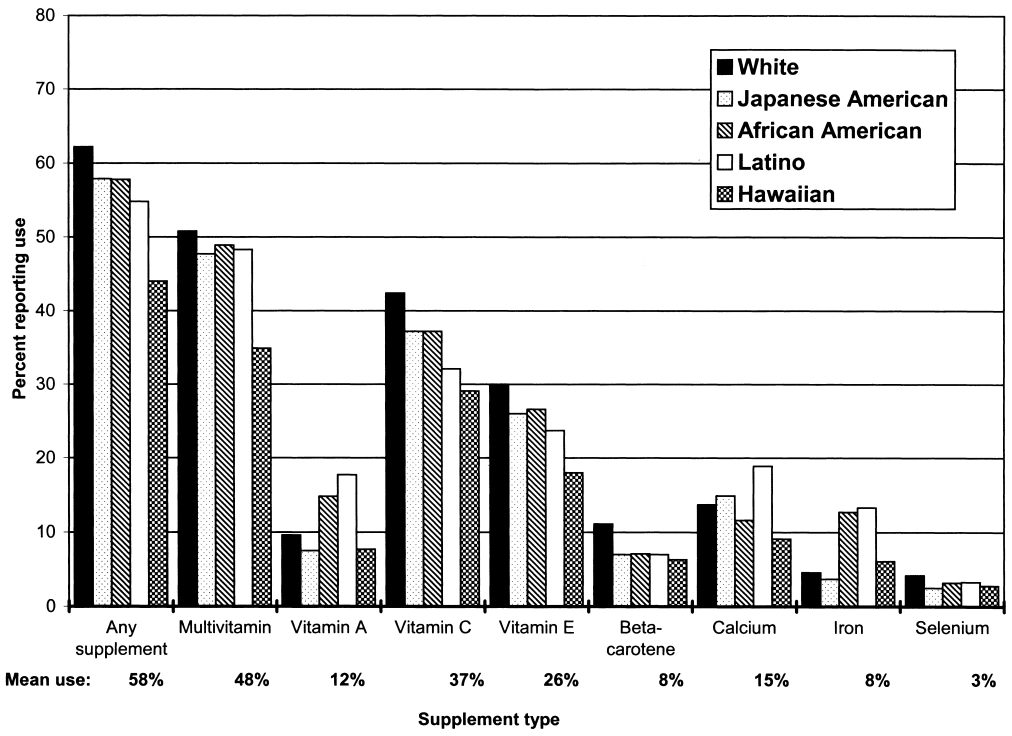


**FIGURE 1.** Age-standardized use of eight dietary supplements during the past year by healthy men in the Hawaii–Los Angeles Multiethnic Cohort Study ($n$ = 44,020), United States. For this analysis, healthy participants were defined as those reporting no history of cardiovascular disease risk factors or cancer. Baseline information for these men aged 45–75 years was collected during 1993–1996.

## RESULTS

Approximately 56 percent of the participants were female, although the proportion varied somewhat by ethnicity (table 1). The gender-adjusted distribution across the three adult age groups was neither balanced nor consistent between ethnicities; more Native Hawaiians were in the youngest age group (45–<55 years), whereas more Latinos were in the middle age group (55–<65 years). Proportionately more of the oldest age group in the cohort was excluded because of cardiovascular disease risk or previous cancer. Similar to the census data for Hawaii and California, the highest level of education completed by the adults varied significantly by ethnicity. Substantially fewer Japanese Americans were obese compared with the other four ethnicities. Native Hawaiians included the largest proportion of current smokers, whereas Japanese Americans and Latinos had the largest proportions of subjects reporting never having smoked. Approximately 56 percent of the Native Hawaiians and less than half of each of the other ethnic-specific groups reported physical activity at least three times or more per week.

Figures 1 and 2 summarize self-reported regular (at least once a week during the last year) dietary supplement use, by ethnicity, among men and women, respectively. The proportions were age standardized within each gender- and ethnic-specific group. Regardless of ethnicity, significantly more women than men reported use of each supplement type, with the exceptions of vitamin A and selenium. Only 53 percent of Native Hawaiians reported use of any of the eight supplement types compared with 69 percent, 68 percent, 66 percent, and 62 percent among Whites, Japanese Americans, African Americans, and Latinos, respectively. A multivitamin was the most frequently reported dietary supplement used by both men and women. At 55 percent, 54 percent, 52 percent, and 51 percent, more than half of the White, African-American, Latino, and Japanese-American adults, respectively, reported regular multivitamin use in contrast to 41 percent of the Native Hawaiians. Within each gender-specific ethnic group, the proportion reporting use of multivitamins was only slightly lower than the proportion reporting use of any dietary supplement, indicating considerable overlap of multivitamin users and persons using single nutrient supplements. Relatively few participants reported use of only one of the single nutrient supplements.

Supplemental vitamin C and vitamin E use was highest among White, African-American, and Japanese-American adults. Japanese-American, Latino, and White adults reported using calcium supplements more frequently than did African Americans or Native Hawaiians. Twelve percent of Whites reported using beta-carotene supplements compared with 7–8 percent of adults of other ethnicities. Supplemental selenium intake did not vary by ethnicity. Use of vitamin A was substantially greater among Latino and African-American adults compared with the other ethnicities

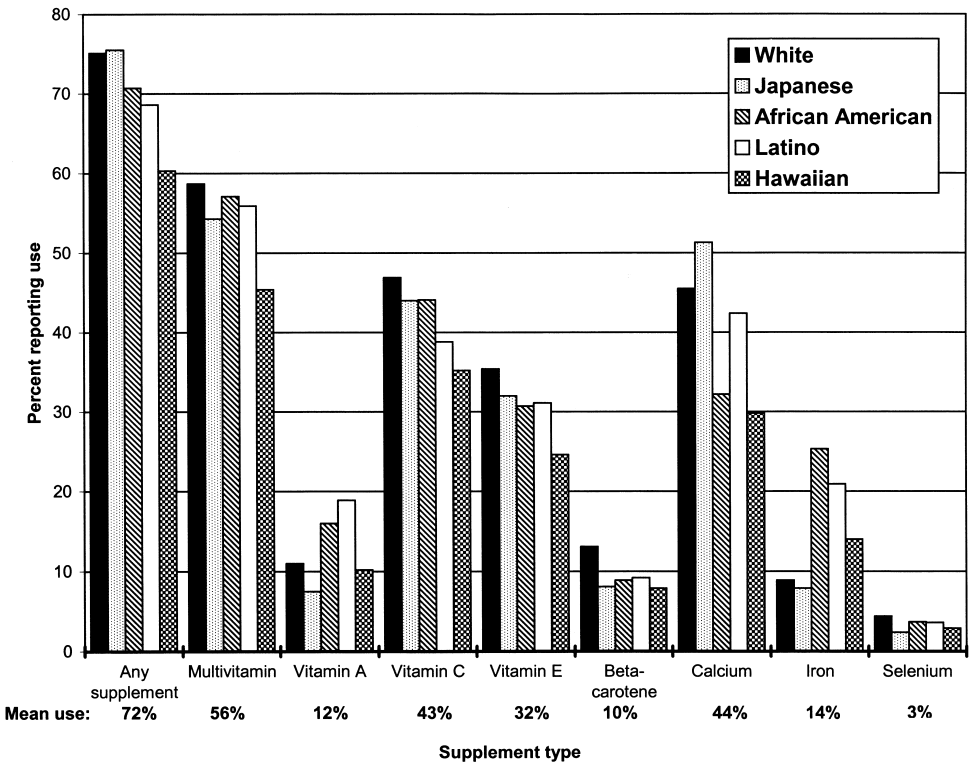


**FIGURE 2.** Age-standardized use of eight dietary supplements during the past year by healthy women in the Hawaii–Los Angeles Multiethnic Cohort Study ($n$ = 56,176), United States. For this analysis, healthy participants were defined as those reporting no history of cardiovascular disease risk factors or cancer. Baseline information for these women aged 45–75 years was collected during 1993–1996.

(18 percent and 16 percent, respectively, vs. 8–10 percent), and iron intake levels were similarly distributed (17 percent and 21 percent, respectively, vs. 6–11 percent). Among males, vitamin C was the most frequently reported supplement after multivitamins. Among females, calcium was the most frequently reported supplement after multivitamins among Japanese Americans and Latinos, whereas vitamin C remained the most frequently used dietary supplement after multivitamins among White, Native Hawaiian, and African-American women. As figures 1 and 2 indicate, despite the variability in use, the patterns of use of the eight dietary supplement types were similar across ethnicities.

Tables 2 (males) and 3 (females) show the odds ratios for demographic and lifestyle factors that were associated with use of any of the eight dietary supplements by the five ethnic groups. Older age, higher educational level, and engaging in regular physical activity were positively associated with dietary supplement use. Obese persons and current smokers were less likely to report such use. Although women were more likely than men to report use of dietary supplements, the demographic and lifestyle factors associated with supplement use were similar for both genders. Average daily hours of sleep, average daily hours of television watching, and number of children were not related to dietary supplement use. Two other factors showed weak and inconsistent associations and were not included in multivariate analyses: 1) family history of cancer was positively associated with dietary supplement use among Japanese-American men (odds ratio = 1.09, 95 percent confidence interval: 1.01, 1.18) and White women (odds ratio = 1.15, 95 percent confidence interval: 1.08, 1.24) only; and 2) persons whose marital status was categorized as divorced, separated, or widowed were slightly more likely to report use of supplements than were married adults (odds ratios = 1.12–1.20), although among only Latino, Japanese-American, or White women and African-American men and women.

Of the dietary variables examined (percentage of energy from fat; grams of alcohol, fiber, vegetables, and fruit), only percentage of energy from fat and grams of fiber and fruit were consistently associated with use of dietary supplements. Persons who consumed a high fat or a low fiber or fruit diet were less likely to use supplements. The estimated area under the curve of the models of demographic and lifestyle characteristics associated with supplement use indicated that the models explained 57–60 percent of the variance; adding in dietary fiber, fruit, and percentage of energy from fat accounted for only an additional 2 percent of the variance.

Data on long-term use of specific dietary supplements (defined as regular use for at least 5 years or longer) are

**TABLE 2. Odds ratios and 95% confidence intervals from multivariate analyses of demographic, lifestyle, and dietary characteristics associated with use of any of eight dietary supplement types by males in five ethnic groups (*n* = 44,020), Hawaii–Los Angeles Multiethnic Cohort Study, United States, baseline assessment 1993–1996**

| | African Americans (*n* = 4,426) | | Native Hawaiians (*n* = 2,678) | | Latinos (*n* = 11,765) | | Japanese Americans (*n* = 12,294) | | Whites (*n* = 12,857) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Odds ratio | 95% CI* | Odds ratio | 95% CI | Odds ratio | 95% CI | Odds ratio | 95% CI | Odds ratio | 95% CI |
| *Model 1: demographic and lifestyle factors* | | | | | | | | | | |
| Age (years) | | | | | | | | | | |
| 45–<55 | 1.0 | | 1.0 | | 1.0 | | 1.0 | | 1.0 | |
| 55–< 65 | 1.05 | 0.90, 1.22 | 1.09 | 0.91, 1.31 | 1.22 | 1.12, 1.33 | 1.26 | 1.15, 1.38 | 1.18 | 1.08, 1.29 |
| 65–75 | 0.95 | 0.82, 1.11 | 1.03 | 0.82, 1.31 | 1.38 | 1.25, 1.53 | 1.58 | 1.43, 1.74 | 1.17 | 1.07, 1.29 |
| Educational level | | | | | | | | | | |
| <High school | 1.0 | | 1.0 | | 1.0 | | 1.0 | | 1.0 | |
| Post-high school/vocational | 1.20 | 1.04, 1.39 | 1.65 | 1.37, 1.99 | 1.12 | 1.03, 1.23 | 1.31 | 1.19, 1.44 | 1.43 | 1.29, 1.59 |
| ≥College graduate | 1.30 | 1.10, 1.54 | 1.97 | 1.60, 2.43 | 1.28 | 1.14, 1.44 | 1.57 | 1.42, 1.73 | 1.53 | 1.39, 1.69 |
| Body mass index | | | | | | | | | | |
| Normal | 1.0 | | 1.0 | | 1.0 | | 1.0 | | 1.0 | |
| Overweight | 0.93 | 0.81, 1.07 | 0.85 | 0.71, 1.03 | 0.83 | 0.76, 0.90 | 0.82 | 0.76, 0.89 | 0.78 | 0.72, 0.84 |
| Obese | 0.76 | 0.62, 0.93 | 0.71 | 0.57, 0.89 | 0.65 | 0.58, 0.74 | 0.70 | 0.58, 0.85 | 0.68 | 0.60, 0.78 |
| Smoking status | | | | | | | | | | |
| Never | 1.0 | | 1.0 | | 1.0 | | 1.0 | | 1.0 | |
| Former | 0.99 | 0.85, 1.16 | 1.14 | 0.95, 1.38 | 0.96 | 0.88, 1.04 | 1.00 | 0.92, 1.09 | 1.05 | 0.97, 1.14 |
| Current | 0.81 | 0.68, 0.96 | 0.80 | 0.64, 0.99 | 0.79 | 0.71, 0.88 | 0.84 | 0.75, 0.93 | 0.76 | 0.68, 0.84 |
| Physical activity (resulting in sweat) | | | | | | | | | | |
| Never | 1.0 | | 1.0 | | 1.0 | | 1.0 | | 1.0 | |
| 1–2 times/week | 1.37 | 1.15, 1.64 | 1.21 | 0.93, 1.58 | 1.20 | 1.03, 1.23 | 1.10 | 0.99, 1.21 | 1.02 | 0.91, 1.14 |
| ≥3 times/week | 1.39 | 1.19, 1.63 | 1.29 | 1.02, 1.63 | 1.28 | 1.14, 1.44 | 1.34 | 1.22, 1.48 | 1.34 | 1.21, 1.48 |
| *Model 2: dietary factors adjusted for all demographic and lifestyle variables listed above* | | | | | | | | | | |
| Percentage of energy from fat | | | | | | | | | | |
| Quartile 1 | 1.0 | | 1.0 | | 1.0 | | 1.0 | | 1.0 | |
| Quartile 2 | 0.82 | 0.65, 1.03 | 0.92 | 0.74, 1.15 | 1.03 | 0.91, 1.16 | 0.93 | 0.85, 1.02 | 0.91 | 0.81, 1.02 |
| Quartile 3 | 0.91 | 0.73, 1.12 | 1.11 | 0.89, 1.39 | 0.97 | 0.86, 1.09 | 0.92 | 0.83, 1.02 | 0.80 | 0.72, 0.89 |
| Quartile 4 | 0.81 | 0.66, 0.98 | 0.97 | 0.77, 1.22 | 0.82 | 0.73, 0.92 | 0.82 | 0.72, 0.93 | 0.70 | 0.63, 0.78 |
| Fiber intake (g/day) | | | | | | | | | | |
| Quartile 1 | 1.0 | | 1.0 | | 1.0 | | 1.0 | | 1.0 | |
| Quartile 2 | 1.20 | 1.02, 1.42 | 1.24 | 1.00, 1.55 | 1.30 | 1.14, 1.48 | 1.24 | 1.13, 1.36 | 1.25 | 1.12, 1.39 |
| Quartile 3 | 1.21 | 1.02, 1.44 | 1.48 | 1.18, 1.85 | 1.41 | 1.25, 1.59 | 1.41 | 1.27, 1.56 | 1.46 | 1.31, 1.63 |
| Quartile 4 | 1.76 | 1.47, 2.10 | 1.68 | 1.33, 2.10 | 1.52 | 1.35, 1.70 | 1.82 | 1.60, 2.07 | 1.74 | 1.56, 1.96 |
| Fruit intake (g/day) | | | | | | | | | | |
| Quartile 1 | 1.0 | | 1.0 | | 1.0 | | 1.0 | | 1.0 | |
| Quartile 2 | 1.10 | 0.93, 1.31 | 0.92 | 0.73, 1.16 | 1.30 | 1.17, 1.45 | 1.13 | 1.03, 1.26 | 1.21 | 1.09, 1.34 |
| Quartile 3 | 1.50 | 1.23, 1.83 | 1.34 | 1.04, 1.73 | 1.47 | 1.30, 1.66 | 1.22 | 1.08, 1.37 | 1.26 | 1.13, 1.42 |
| Quartile 4 | 1.39 | 1.10, 1.76 | 1.24 | 0.93, 1.67 | 1.56 | 1.37, 1.77 | 1.33 | 1.15, 1.54 | 1.29 | 1.13, 1.48 |

* CI, confidence interval.

shown in table 4. Multivitamins, the supplement type used most frequently, had the largest proportion of participants reporting long-term use. Selenium, infrequently reported by participants at the baseline assessment, had the smallest proportion of long-term users. For the other dietary supplement types assessed, the proportion of long-term users ranged from a low of 10 percent (β-carotene in Latino women) to a high of 57 percent (vitamin C in Japanese-American men). In comparison to the other groups, fewer Latinos reported using any of the supplements for 5 years or longer.

## DISCUSSION

Although US surveys have reported on current use of dietary supplements, data from the present study add unique

**TABLE 3. Odds ratios and 95% confidence intervals from multivariate analyses of demographic, lifestyle, and dietary characteristics associated with use of any of eight dietary supplement types by females in five ethnic groups (*n* = 56,176), Hawaii–Los Angeles Multiethnic Cohort Study, United States, baseline assessment 1993–1996**

| | African Americans (*n* = 7,592) | | Native Hawaiians (*n* = 3,800) | | Latinos (*n* = 12,745) | | Japanese Americans (*n* = 16,060) | | Whites (*n* = 15,979) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Odds ratio | 95% CI* | Odds ratio | 95% CI | Odds ratio | 95% CI | Odds ratio | 95% CI | Odds ratio | 95% CI |
| *Model 1: demographic and lifestyle factors* | | | | | | | | | | |
| Age (years) | | | | | | | | | | |
| 45–<55 | 1.0 | | 1.0 | | 1.0 | | 1.0 | | 1.0 | |
| 55–< 65 | 1.01 | 0.89, 1.14 | 1.08 | 0.91, 1.27 | 1.21 | 1.11, 1.32 | 1.51 | 1.38, 1.66 | 1.29 | 1.18, 1.40 |
| 65–75 | 0.99 | 0.87, 1.12 | 1.02 | 0.83, 1.25 | 1.20 | 1.08, 1.34 | 1.49 | 1.36, 1.63 | 1.28 | 1.16, 1.41 |
| Educational level | | | | | | | | | | |
| ≤High school | 1.0 | | 1.0 | | 1.0 | | 1.0 | | 1.0 | |
| Post-high school/vocational | 1.29 | 1.14, 1.45 | 1.62 | 1.39, 1.89 | 1.18 | 1.07, 1.30 | 1.10 | 1.00, 1.21 | 1.38 | 1.26, 1.52 |
| ≥College graduate | 1.44 | 1.26, 1.65 | 1.67 | 1.38, 2.02 | 1.43 | 1.24, 1.64 | 1.07 | 0.97, 1.18 | 1.52 | 1.38, 1.67 |
| Body mass index | | | | | | | | | | |
| Normal | 1.0 | | 1.0 | | 1.0 | | 1.0 | | 1.0 | |
| Overweight | 0.85 | 0.76, 0.96 | 0.80 | 0.69, 0.94 | 0.84 | 0.77, 0.91 | 0.71 | 0.64, 0.78 | 0.76 | 0.70, 0.83 |
| Obese | 0.74 | 0.65, 0.84 | 0.61 | 0.52, 0.73 | 0.56 | 0.51, 0.62 | 0.44 | 0.36, 0.53 | 0.53 | 0.47, 0.59 |
| Smoking status | | | | | | | | | | |
| Never | 1.0 | | 1.0 | | 1.0 | | 1.0 | | 1.0 | |
| Former | 1.10 | 0.98, 1.24 | 1.14 | 0.97, 1.34 | 0.99 | 0.90, 1.09 | 1.07 | 0.97, 1.17 | 1.10 | 1.01, 1.19 |
| Current | 0.87 | 0.77, 1.00 | 0.71 | 0.60, 0.83 | 0.81 | 0.71, 0.91 | 0.72 | 0.64, 0.81 | 0.78 | 0.70, 0.86 |
| Physical activity (resulting in sweat) | | | | | | | | | | |
| Never | 1.0 | | 1.0 | | 1.0 | | 1.0 | | 1.0 | |
| 1–2 times/week | 1.35 | 1.18, 1.55 | 1.29 | 1.07, 1.56 | 1.20 | 1.08, 1.32 | 1.14 | 1.04, 1.24 | 1.24 | 1.13, 1.37 |
| ≥3 times/week | 1.67 | 1.49, 1.88 | 1.38 | 1.17, 1.64 | 1.51 | 1.38, 1.65 | 1.40 | 1.28, 1.53 | 1.43 | 1.31, 1.57 |
| *Model 2: dietary factors adjusted for all demographic and lifestyle variables listed above* | | | | | | | | | | |
| Percentage of energy from fat | | | | | | | | | | |
| Quartile 1 | 1.0 | | 1.0 | | 1.0 | | 1.0 | | 1.0 | |
| Quartile 2 | 0.91 | 0.75, 1.10 | 1.03 | 0.84, 1.27 | 1.01 | 0.89, 1.14 | 0.98 | 0.89, 1.08 | 0.89 | 0.79, 1.00 |
| Quartile 3 | 0.90 | 0.75, 1.07 | 0.92 | 0.75, 1.12 | 0.89 | 0.79, 1.01 | 0.92 | 0.83, 1.02 | 0.79 | 0.70, 0.88 |
| Quartile 4 | 0.68 | 0.58, 0.81 | 0.80 | 0.65, 0.98 | 0.75 | 0.67, 0.85 | 0.82 | 0.73, 0.93 | 0.63 | 0.57, 0.71 |
| Fiber intake (g/day) | | | | | | | | | | |
| Quartile 1 | 1.0 | | 1.0 | | 1.0 | | 1.0 | | 1.0 | |
| Quartile 2 | 1.23 | 1.07, 1.41 | 1.22 | 1.01, 1.48 | 1.11 | 0.98, 1.26 | 1.32 | 1.20, 1.45 | 1.25 | 1.13, 1.39 |
| Quartile 3 | 1.45 | 1.25, 1.68 | 1.28 | 1.05, 1.55 | 1.38 | 1.22, 1.56 | 1.54 | 1.39, 1.71 | 1.47 | 1.32, 1.63 |
| Quartile 4 | 1.62 | 1.40, 1.88 | 1.40 | 1.15, 1.69 | 1.68 | 1.50, 1.89 | 1.74 | 1.53, 1.97 | 1.60 | 1.43, 1.80 |
| Fruit intake (g/day) | | | | | | | | | | |
| Quartile 1 | 1.0 | | 1.0 | | 1.0 | | 1.0 | | 1.0 | |
| Quartile 2 | 1.21 | 1.04, 1.40 | 1.20 | 0.98, 1.47 | 1.26 | 1.12, 1.42 | 1.23 | 1.11, 1.37 | 1.19 | 1.07, 1.33 |
| Quartile 3 | 1.36 | 1.15, 1.61 | 1.36 | 1.08, 1.71 | 1.54 | 1.35, 1.75 | 1.48 | 1.31, 1.67 | 1.31 | 1.17, 1.48 |
| Quartile 4 | 1.40 | 1.15, 1.70 | 1.32 | 1.02, 1.71 | 1.54 | 1.34, 1.77 | 1.29 | 1.11, 1.49 | 1.41 | 1.22, 1.62 |

* CI, confidence interval.

information. To our knowledge, levels of supplement use among Japanese Americans and Native Hawaiians have not been specifically reported nor compared with levels of use among similar adults of African-American, Hispanic, or White ancestry. In addition, by excluding adults who reported certain major chronic diseases and/or risk factors for chronic disease, we minimized the influence of preexisting disease on the reported use of supplements. Finally, we analyzed both the frequency of supplement intake and the time period over which the supplement had been used, providing insight into changes in patterns of use.

Few other studies have reported supplement use by ethnicity. Neuhouser et al. (19) defined regular supplementation as three or more times per week and reported levels of 53–70 percent among Black, Hispanic, White, and Asian males participating in the Prostate Cancer Prevention Trials.

**TABLE 4. Age-standardized proportion (%) of supplement users* reporting regular use of specific dietary supplements for 5 years or more, by gender-specific ethnic group, Hawaii–Los Angeles Multiethnic Cohort Study, United States, baseline assessment 1993–1996**

| | African Americans | Native Hawaiians | Latinos | Japanese Americans | Whites |
|---|---|---|---|---|---|
| Males | | | | | |
| Multivitamins | 49.6 | 50.6 | 41.6 | 63.6 | 60.5 |
| Vitamin A | 32.5 | 33.4 | 25.5 | 44.7 | 41.1 |
| Vitamin C | 37.5 | 41.9 | 30.4 | 56.7 | 54.1 |
| Vitamin E | 35.1 | 38.4 | 29.3 | 48.4 | 45.7 |
| β-Carotene | 18.3 | 19.4 | 13.9 | 25.9 | 25.4 |
| Calcium | 25.0 | 28.0 | 20.9 | 41.4 | 37.2 |
| Iron | 20.1 | 21.2 | 17.6 | 32.6 | 22.2 |
| Selenium | 14.9 | 19.7 | 10.3 | 26.7 | 26.5 |
| Females | | | | | |
| Multivitamins | 48.8 | 53.6 | 39.3 | 61.5 | 62.3 |
| Vitamin A | 28.2 | 32.5 | 21.4 | 35.7 | 38.0 |
| Vitamin C | 35.9 | 41.1 | 27.6 | 52.5 | 53.4 |
| Vitamin E | 32.3 | 38.9 | 25.4 | 45.2 | 44.6 |
| β-Carotene | 13.0 | 18.7 | 10.2 | 17.4 | 20.3 |
| Calcium | 25.1 | 32.6 | 22.5 | 42.6 | 40.9 |
| Iron | 23.6 | 25.3 | 15.5 | 26.1 | 25.3 |
| Selenium | 9.1 | 14.2 | 7.1 | 14.4 | 19.7 |

* Proportion is based on users of that type of supplement. For instance, 49.6% of the African-American men using multivitamins reported use of 5 years or more, and 35.1% of those using vitamin E reported use for 5 years or more.

Frank et al. (10), asking about current use of supplements five or more times weekly during the past month, reported levels of use of 58–65 percent among Hispanic, African-American, Asian, and White US female physicians. We found similar, yet slightly higher levels (62–69 percent) among our adults of these same ethnicities, who were representative of a broader range of socioeconomic levels. Nationally representative surveys report slightly lower use in the past month among US adults (35–55 percent) and use 7–10 percent lower among African-American and Hispanic adults compared with Whites (7, 20, 21).

Our data are consistent with other reports indicating that multivitamins are the most frequently reported supplement type among all ethnic-gender groups (6, 7, 20, 22). The predominance of multivitamin use among these reportedly healthy participants is particularly interesting. Rather than augmenting a specific nutrient, most supplement users choose a product providing multiple nutrients for which dietary recommendations exist. This selection suggests that these adults are not worried about deficiencies in specific nutrients but may be more concerned about nutrient adequacy in general or possibly think that a multivitamin-type supplement provides assurance against nutrient deficiencies.

Use of any type of dietary supplement was approximately 14 percent greater, and use of multivitamins was approximately 8 percent greater, among women compared with men, regardless of ethnicity. The National Health Interview Survey and NHANES III found that approximately 6–8 percent more women than men use supplements (7, 20). In our data, the proportion of supplement users among men and women varied the most for calcium. Three times as many women as men reported use of calcium supplements regardless of ethnicity, suggesting that women may be more concerned about osteoporosis. Selenium and vitamin A were the only supplements for which intake among men and women did not differ substantially, although only 3 percent and 12 percent, respectively, reported use of either of these specific supplements.

Although patterns of supplement use varied little across ethnicities, there were two interesting exceptions. Age-standardized use of vitamin A and iron supplements among Latinos and African Americans was approximately twice that of the other ethnic groups, regardless of gender. This result suggests the possibility that supplemental intakes of these nutrients are being promoted among these ethnic groups or in Los Angeles; this finding should be investigated further. Additionally, substantially more Japanese-American and White participants in the current study reported long-term use of supplements, suggesting that use of various supplement products is relatively recent among the African-American, Native Hawaiian, and especially Latino participants.

In general, older persons were more likely to use supplements. However, similar to the findings of Frank et al. (10) among African-American and Hispanic female physicians, dietary supplementation did not increase with age among our

African-American and Native Hawaiian adults. The absence of a monotonic linear increase in supplement use with age for many groups may initially seem surprising. Instead, a threshold effect was observed, where use remained relatively constant after age 55 years. Supportive of this relation, a cross-sectional examination of our data revealed that reported supplement use increased with age among those in the 45–55-year age range. Supplement use may already be an established behavior after age 55 years.

Contrary to our expectations, factors associated in multivariate models with dietary supplement use tended to be similar across gender-specific ethnic groups. The lifestyle and demographic relations found suggest that a "health conscious" attitude predominates among dietary supplement users. Educational level was associated with a substantially increased likelihood of supplement use among all gender-specific ethnic groups except Japanese-American women. More years of education may imply a greater awareness of the role of nutrition in good health.

Similar to the findings of Houston et al. (8), who assessed community-dwelling adults aged 60 years or older, and findings among men in the Prostate Cancer Prevention Trials, as reported by Neuhouser et al. (19), obesity was inversely associated with supplement use, reinforcing the notion that supplement users focus attention on healthy behaviors. In the current analysis, this finding was consistent across ethnic populations, despite widely varying proportions of obese adults. Likewise, the reduced rate of supplementation among current smokers was consistent with the "healthy lifestyle choices" linkage to supplement use, as is the finding that former smokers were similar to never smokers in their dietary supplement use. Engaging in regular physical activity, again a healthy lifestyle choice, was significantly associated with an increased likelihood of supplement use, although usual hours spent watching television (as an estimate of sedentary behavior) was not related to use of dietary supplements. Healthy dietary choices, as measured by higher fiber and fruit intakes and by a lower fat intake, were also associated with supplement use among most of the gender-specific ethnic groups. Participants reporting the highest daily levels of dietary fiber intake were 40–82 percent more likely to report use of dietary supplements compared with those adults who had the lowest levels of daily fiber intake.

There are several caveats to the current analysis. By excluding those persons who had potential risk factors for and a history of cardiovascular disease and cancer, older participants were more likely to be excluded, and this exclusion was disproportionate across ethnic groups. The proportion of participants excluded because of cardiovascular disease risk factors ranged from 35 percent among Whites to almost 63 percent among African Americans. Ten percent of the White participants were excluded because of a previous cancer compared with only 5.5 percent of the Latinos. Thus, by intent, these findings apply only to persons reporting no history of these major chronic diseases.

Additionally, only eight specific supplement types were included in our assessment. By narrowing the focus of supplement types, we may have misclassified some participants as nonusers of supplements because they regularly used a type of dietary supplement excluded in our questionnaire. However, Murphy et al. (15) compared supplement intake on the dietary history questionnaire and supplement intake reported on three 24-hour recalls for a representative sampling of the cohort and found that few participants used vitamin or mineral supplements that were excluded from the dietary history questionnaire.

Although the association of chronic supplement use with subsequent cardiovascular disease or cancer outcomes has been pursued in recent studies (23–27), the populations were predominantly White, and associations for non-White adults have received little attention. Our analysis takes one step in that direction by reporting dietary supplement use among healthy African-American, Native Hawaiian, Latino, and Japanese-American adults and thus provides a basis for future analyses in relation to chronic disease outcomes.

Our models of demographic and lifestyle factors did not explain all of the variation between users and nonusers of dietary supplements. However, users could be distinguished from nonusers regarding factors thought to be indicative of a healthy lifestyle, regardless of gender or ethnicity. Such findings may be particularly important to consider in analyses of observational or prevention trials, and they highlight the difficulty in separating the effects of diet and supplement use on disease etiology. The high prevalence of dietary supplement use across the different ethnic populations reinforces the need to include supplemental sources when evaluating the relation between nutrient intakes and disease outcomes.

## ACKNOWLEDGMENTS

This research was supported in part by grant CA054281 from the National Institutes of Health, Bethesda, Maryland.

## REFERENCES

1. Levitt JA. Center for Food Safety and Applied Nutrition, Food and Drug Administration. Statement to the US House of Representatives Committee on Government Reform, March 20, 2001. (http://www.cfsan.fda.gov/~lrd/st010320.html).
2. Ervin RB, Wright JD, Kennedy-Stephenson JK. Use of dietary supplements in the United States, 1988–94. Vital Health Stat 11 1999;Jun(244):i–iii, 1–14.
3. The Food and Nutrition Board. Dietary reference intakes for thiamin, riboflavin, niacin, vitamin B6, folate, vitamin B12, pantothenic acid, biotin, and choline. Washington, DC: National Academy Press, 1998.
4. Russell RM, Rasmussen H, Lichtenstein AH. Modified food guide pyramid for people over seventy years of age. J Nutr 1999;129:751–3.
5. Patterson RE, Kristal AR, Levy L, et al. Validity of methods used to assess vitamin and mineral supplement use. Am J Epidemiol 1998;148:643–9.
6. Block G, Sinha R, Gridley G. Collection of dietary-supplement data and implications for analysis. Am J Clin Nutr 1994; 59(suppl):232s–9s.
7. Slesinski MJ, Subar AF, Kahle LL. Trends in use of vitamin and mineral supplements in the United States: the 1987 and 1992 National Health Interview Surveys. J Am Diet Assoc

1995;95:921–3.
8. Houston DK, Johnson MA, Daniel TD, et al. Health and dietary characteristics of supplement users in an elderly population. Int J Vitam Nutr Res 1997;67:183–91.
9. Nayge RM, Reed DB. Factors associated with the intake of dietary supplements. Fam Econ Nutr Rev 1999;12:43–8.
10. Frank E, Bendich A, Denniston M. Use of vitamin-mineral supplements by female physicians in the United States. Am J Clin Nutr 2000;72:969–75.
11. Rock CL, Newman V, Flatt SW, et al. Nutrient intakes from foods and dietary supplements in women at risk for breast cancer recurrence. The Women's Healthy Eating and Living Study Group. Nutr Cancer 1997;29:133–9.
12. Kolonel LN, Henderson BE, Hankin JH, et al. A multiethnic cohort in Hawaii and Los Angeles: baseline characteristics. Am J Epidemiol 2000;151:346–57.
13. Stram DO, Hankin JH, Wilkens LR, et al. Calibration of the dietary questionnaire for a multiethnic cohort in Hawaii and Los Angeles. Am J Epidemiol 2000;151:358–70.
14. World Health Organization (WHO) Consultation on Obesity (Geneva, 3–5 June 1997). Obesity epidemic puts millions at risk from related diseases. (Press release WHO/46). (http://www.who.int/archives/inf-pr-1977/en/pr97-46.html).
15. Murphy SP, Wilkens LR, Hankin JH, et al. Comparison of two instruments for quantifying intake of vitamin and mineral supplements: a brief questionnaire versus three 24-hour recalls. Am J Epidemiol 2002;156:669–75.
16. SAS Institute, Inc. SAS statistical software system, version 6.12. Cary, NC: SAS Institute, Inc, 1996.
17. Rossi PH, Wright J, Anderson A. Handbook of survey research (quantitative studies in social relations). San Diego, CA: Academic Press, 1985:44–5.
18. Stata Corporation. Stata statistical software, intercooled stata, release 6.0. College Station, TX: Stata Corporation, 1999.
19. Neuhouser ML, Kristal AR, Patterson RE, et al. Dietary supplement use in the Prostate Cancer Prevention Trial: implications for prevention trials. Nutr Cancer 2001;39:12–18.
20. Balluz LS, Kieszak SM, Philen RM, et al. Vitamin and mineral supplement use in the United States. Arch Fam Med 2000;9:258–62.
21. Moss AJ, Levy AS, Kim I, et al. Use of vitamin and mineral supplements in the United States: current users, types of products, and nutrients. Washington, DC: US Department of Health and Human Services, 1989. (Advance data, Vital and Health Statistics, no. 174).
22. Slesinski MJ, Subar AF, Kahle LL. Dietary intake of fat, fiber and other nutrients is related to the use of vitamin and mineral supplements in the United States: the 1992 National Health Interview Survey. J Nutr 1996;126:3001–8.
23. Brown GB, Zhao XQ, Chait A, et al. Simvastatin and niacin, antioxidant vitamins, or the combination for the prevention of coronary disease. N Engl J Med 2001;345:1583–92.
24. Zhang SM, Giovannucci EL, Hunter DJ, et al. Vitamin supplement use and the risk of non-Hodgkin's lymphoma among women and men. Am J Epidemiol 2001;153:1056–63.
25. Zhang SM, Calle EE, Petrelli JM, et al. Vitamin supplement use and fatal non-Hodgkin's lymphoma among US men and women. Am J Epidemiol 2001;153:1064–70.
26. Michaud DS, Spiegelman D, Clinton SK, et al. Prospective study of dietary supplements, macronutrients, micronutrients, and risk of bladder cancer in US men. Am J Epidemiol 2000;152:1145–53.
27. Jacobs EJ, Connell CJ, Patel AV, et al. Vitamin C and vitamin E supplement use and colorectal cancer mortality in a large American Cancer Society cohort. Cancer Epidemiol Biomarkers Prev 2001;10:17–23.