Brief Communication: The Prevalence of High Intake of Vitamin E from the Use of Supplements among U.S. Adults

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Background: People who consume at least 400 IU of vitamin E per day from supplements may be at slightly increased risk for premature mortality.

Objective: To estimate the percentage of U.S. adults age 20 years or older who consume at least 400 IU of vitamin E per day through the use of vitamins, minerals, or other dietary supplements.

Design: Cross-sectional analysis.


Patients: Representative sample of the civilian, noninstitutionalized U.S. population.

Measurements: Participants answered questions about the use of vitamins, minerals, or other dietary supplements.

Results: Among 4609 adults, 11.3% (95% CI, 9.7% to 13.1%) consumed at least 400 IU of vitamin E per day from supplements. Such intake increased with age, was about equal for men and women, and was more common among white persons (14.1%; CI, 11.9% to 16.7%) than African-American (3.7% [CI, 2.6% to 5.2%]) or Mexican-American persons (3.9% [CI, 2.8% to 5.4%]). The median dietary intake of vitamin E was 8.8 IU per day.

Limitations: Information about vitamin E intake was self-reported.

Conclusions: The use of vitamin E supplements in dosages of at least 400 IU per day is common among U.S. adults.

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In a recent meta-analysis of randomized clinical trials, Miller and colleagues reported that the intake of vitamin E of at least 400 IU per day from supplements was associated with a small increase in mortality from all causes (1). The recent findings of the Women’s Health Study, in which participants consumed 600 IU of vitamin E every other day, were consistent with the results from this meta-analysis (2, 3). Furthermore, the Heart Outcomes Prevention Evaluation researchers linked the use of 400 IU of vitamin E per day to an increased risk for congestive heart failure (4).

Vitamin E intake of 400 IU per day or greater can practicably be achieved only through supplementation. Among adults older than 20 years of age who participated in the U.S. Department of Agriculture's 1994–1996 Continuing Surveys of Food Intake by Individuals, the median intake of vitamin E was 5.6 mg of α-tocopherol equivalents per day (6.7 IU) for men and 4.0 (4.8 IU) for women (5). Supplemental use of vitamins and minerals has increased in the United States, and supplemental use of vitamin E increased rapidly between 1987 and 2000 (6, 7). The extent to which supplements containing high doses of vitamin E are used in the United States remains incompletely documented, however. Therefore, our objectives were to estimate the percentage of U.S. adults who use supplements leading to intake of vitamin E of 400 IU or greater per day and to examine the social and demographic variations in these estimates.

METHODS

We used data from the National Health and Nutrition Examination Survey (NHANES) conducted from 1999 to 2000 (8). This survey included a representative sample of the civilian, noninstitutionalized U.S. population selected through stratified, multistage sampling. Trained interviewers, using a computer-assisted personal interview system, interviewed participants at home. Subsequently, participants completed additional questionnaires (including a single 24-hour dietary recall); underwent basic neurosensory, anthropometric, fitness, and oral health evaluations; and provided a blood sample at the mobile examination center. The response rate was 81.9% for those interviewed and 76.3% for those examined. An Institutional Review Board at the Centers for Disease Control and Prevention approved the survey. Participants provided informed consent.

Participants who responded affirmatively to the question “Have you used or taken any vitamins, minerals, or other dietary supplements in the past month?” were asked to provide additional details about the dose, frequency, and duration of use. The interviewer also asked to see the containers of the supplements to record information about the name and manufacturer of the supplements. If participants could not produce the containers, interviewers asked them...
to recall this information. We estimated the dietary intake of vitamin E from a single 24-hour recall.

Laboratory personnel measured serum concentrations of α- and γ-tocopherol using a Waters Alliance high-performance liquid chromatography system (Waters Corp., Milford, Massachusetts). A detailed description of laboratory quality control procedures used in the survey can be accessed at the Centers for Disease Control and Prevention Web site (9).

Among participants age 20 years or older, we estimated the percentage (95% CI) who 1) did not use supplements or used supplements that did not contain vitamin E, 2) consumed less than 400 IU per day from the use of supplements, and 3) used supplements providing at least 400 IU per day. We examined the variation in the intake of vitamin E, 400 IU or greater per day, by the following characteristics of participants: age; sex; race or ethnicity; educational status; presence of chronic conditions (coronary heart disease, angina pectoris, stroke, and diabetes); smoking behavior; strata of blood pressure; serum total cholesterol concentration; and body mass index. We present results only for the 3 major racial or ethnic groups (white, African-American, and Mexican-American) because the sample sizes for the other groups were small. Other results are based on all available data.

For 2-sample tests of proportions, we used a t-test. For characteristics with 3 levels, we tested the differences in the intake of vitamin E from supplements with a test for linear trend. We used SUDAAN statistical analysis software (Research Triangle Institute, Research Triangle Park, North Carolina) to account for the complex sampling design of the survey and to produce proper estimates of the standard errors (10).

RESULTS

Figure 1 shows the numbers of participants who were included in the analyses. The participants who did not have a serum determination of α-tocopherol were on average 2.2 years older (P = 0.017) than the other participants, but the percentages who were male, were white, and who had at least a high school education did not significantly differ.

Overall, 11.3% (CI, 9.7% to 13.1%) of adults used supplements that led to a daily intake of 400 IU or greater, and 25.7% (CI, 24.0% to 27.5%) consumed less than 400 IU per day from such supplements. As illustrated in the Table, such intake increased with increasing age (P < 0.001 for linear trend), was about equal for men and women (P > 0.2), and was more common among white persons than African-American (P < 0.001) or Mexican-American persons (P < 0.001). Participants who had a history of coronary heart disease, angina pectoris, stroke, or diabetes were more likely to use high doses of vitamin E than participants without these conditions (P < 0.001 for all age-adjusted differences).

Figure 1. Sample-size flow for 1999–2000 National Health and Nutrition Examination Survey.
### Table. Unadjusted Percentages of Adults Aged 20 Years or Older Who Consume 400 IU of Vitamin E per Day from the Use of Vitamin, Mineral, or Dietary Supplements (1999–2000 National Health and Nutrition Examination Survey)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Participants Who Provided Information about Supplement Use</th>
<th>Participants Who Provided Information To Allow Estimation of Vitamin E Intake</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Overall, n</td>
<td>Participants Taking Any Supplements, %</td>
</tr>
<tr>
<td>Total</td>
<td>4863</td>
<td>52.0 ± 1.4</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20–39 y</td>
<td>1693</td>
<td>43.3 ± 1.8</td>
</tr>
<tr>
<td>40–59 y</td>
<td>1345</td>
<td>56.1 ± 1.9</td>
</tr>
<tr>
<td>≥60 y</td>
<td>1825</td>
<td>63.3 ± 1.7</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>2261</td>
<td>46.9 ± 1.5</td>
</tr>
<tr>
<td>Women</td>
<td>2602</td>
<td>56.7 ± 1.7</td>
</tr>
<tr>
<td>Race or ethnicity</td>
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<tr>
<td>White</td>
<td>2229</td>
<td>58.2 ± 1.9</td>
</tr>
<tr>
<td>African-American</td>
<td>922</td>
<td>36.0 ± 2.2</td>
</tr>
<tr>
<td>Mexican-American</td>
<td>1276</td>
<td>33.3 ± 2.3</td>
</tr>
<tr>
<td>Education</td>
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<tr>
<td>Less than high school</td>
<td>1889</td>
<td>34.7 ± 2.1</td>
</tr>
<tr>
<td>High school graduate</td>
<td>1095</td>
<td>48.4 ± 2.2</td>
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<tr>
<td>More than high school</td>
<td>1863</td>
<td>62.2 ± 1.5</td>
</tr>
<tr>
<td>History of heart attack or coronary heart disease</td>
<td></td>
<td></td>
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<tr>
<td>Yes</td>
<td>310</td>
<td>60.9 ± 2.8</td>
</tr>
<tr>
<td>No</td>
<td>4523</td>
<td>51.5 ± 1.5</td>
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<tr>
<td>History of angina pectoris</td>
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<td></td>
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<tr>
<td>Yes</td>
<td>179</td>
<td>64.3 ± 4.2</td>
</tr>
<tr>
<td>No</td>
<td>4659</td>
<td>51.7 ± 1.4</td>
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<tr>
<td>History of stroke</td>
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<td></td>
</tr>
<tr>
<td>Yes</td>
<td>189</td>
<td>60.9 ± 4.8</td>
</tr>
<tr>
<td>No</td>
<td>4670</td>
<td>51.8 ± 1.4</td>
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<tr>
<td>History of diabetes</td>
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<tr>
<td>Yes</td>
<td>479</td>
<td>52.9 ± 3.7</td>
</tr>
<tr>
<td>No</td>
<td>4381</td>
<td>51.9 ± 1.5</td>
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<tr>
<td>Smoking status</td>
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<tr>
<td>Current</td>
<td>996</td>
<td>43.0 ± 1.8</td>
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<tr>
<td>Former</td>
<td>1297</td>
<td>61.2 ± 2.1</td>
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<tr>
<td>Never</td>
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<td>52.2 ± 1.9</td>
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<td>Blood pressure status</td>
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<tr>
<td>Normal</td>
<td>1520</td>
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<tr>
<td>Prehypertension</td>
<td>1215</td>
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<tr>
<td>Hypertension</td>
<td>1689</td>
<td>57.9 ± 1.7</td>
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<td>Cholesterol status</td>
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<tr>
<td>&lt;5.18 mmol/L (180 mg/dL)</td>
<td>1958</td>
<td>48.8 ± 1.8</td>
</tr>
<tr>
<td>5.18–&lt;6.22 mmol/L (200–&lt;240 mg/dL)</td>
<td>1388</td>
<td>56.9 ± 1.8</td>
</tr>
<tr>
<td>≥6.22 mmol/L (≥240 mg/dL)</td>
<td>767</td>
<td>55.4 ± 2.9</td>
</tr>
<tr>
<td>Body mass index</td>
<td></td>
<td></td>
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<tr>
<td>&lt;25 kg/m²</td>
<td>1412</td>
<td>56.3 ± 2.4</td>
</tr>
<tr>
<td>25–&lt;30 kg/m²</td>
<td>1535</td>
<td>51.3 ± 2.0</td>
</tr>
<tr>
<td>≥30 kg/m²</td>
<td>1421</td>
<td>48.1 ± 2.0</td>
</tr>
</tbody>
</table>

*Values reported with a plus/minus sign are means ± SE.

The distribution of concentrations of serum α-tocopherol for 3875 participants reflected the intake of vitamin E (Figure 2). For participants who did not use supplements or did not use supplements containing vitamin E, the median serum concentration of α-tocopherol was 22.85 μmol/L (n = 2506); in comparison, participants using supplements had median concentrations of 30.22 μmol/L (intake of <400 IU per day; n = 953) and 49.03 μmol/L (intake of ≥400 IU per day; n = 3513).
ments, assumed at least 400 IU of vitamin E per day from supplements. Among 4239 participants who attended the mobile examination center and completed the 24-hour dietary recall, the median intake of vitamin E from diet was 7.40 mg of α-tocopherol equivalents per day (8.8 IU) and ranged from 0.03 to 153.26 mg of α-tocopherol equivalents per day (0.04 to 182.7 IU). Among participants who consumed at least 400 IU per day from supplements, 1 participant’s total intake of vitamin E from diet and supplements exceeded 400 IU per day.

DISCUSSION

In this representative sample of U.S. adults, about 11.3% used supplements leading to an intake of vitamin E 400 IU per day or greater. Such intakes were especially high among white participants and those age 60 years or older. Although we could not distinguish among the different forms of tocopherol, α-tocopherol is the most common form found in supplements; its predominance is supported by the serum profiles of concentrations of α-tocopherol in our analyses. The median dietary intake of vitamin E of about 8.8 IU per day reported by adults in the 1999–2000 NHANES emphasizes the difficulty in achieving intakes of 400 IU per day or greater through diet alone.

Vitamin C recycles oxidized α-tocopherol to its unoxidized form. Our results indicate that participants who consumed supplements with vitamin E were very likely to be consuming vitamin C. Furthermore, the use of β-carotene was also common among people using supplements with vitamin E. This may be of some concern because supplementation with β-carotene may increase all-cause mortality (11).

Consistent with previous studies, serum concentrations of α- and γ-tocopherol were inversely associated in the 1999–2000 NHANES (12–14). The correlation coefficients were especially strong among users of supplements containing vitamin E. By decreasing circulating concentra-
tions of γ-tocopherol, supplementation with high doses of α-tocopherol may adversely affect health.

Our results were based on self-reported data and, therefore, are subject to all of the limitations inherent in such data. About 14% of participants reported using supplements containing vitamin E but could not provide sufficient data to allow an estimation of the amount of intake of vitamin E from this source. We could not separate the use of natural from synthetic forms of vitamin E, α-tocopherol from other forms of vitamin E, or tocopherols from tocotrienols.

If people who consume 400 IU or greater of vitamin E per day are indeed at increased risk for premature death, a sizeable percentage of U.S. adults fall into this risk group. Health care professionals are well situated to ask their patients about the use of various vitamin supplements and offer advice about their judicious use. Furthermore, a report showing that 64% of health care professionals had a daily vitamin E intake of 400 IU or greater (15) suggests that many medical professionals themselves may need to reconsider the use of high doses of vitamin E.

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Critical revision of the article for important intellectual content: E.S. Ford, U.A. Ajani, A.H. Mokdad.
Final approval of the article: E.S. Ford, U.A. Ajani.
Statistical expertise: E.S. Ford.