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# Mortality among health-conscious elderly Californians

(epidemiology/vitamin supplements/vitamin E)

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ABSTRACT **In an attempt to obtain epidemiologic evidence regarding the mortality rate among vitamin supplement users, a prospective study was made of 479 elderly Californian respondents to a 1974 questionnaire carried in *Prevention*, a health magazine that advocates vitamin supplement usage. Based on self-reported questionnaire data obtained in 1974 and 1977, this cohort does indeed consume large quantities of vitamin and mineral supplements. In addition, the cohort is quite health conscious and appears to have taken up a "*Prevention* life-style" in recent years. For instance, these individuals are primarily nonsmokers, although about 50% formerly smoked cigarettes. Most of them eat meat, poultry, or fish but do so in moderation; and they consume only modest amounts of alcohol, whole milk, white bread, salt, and sugar. Their socioeconomic status is somewhat higher than the national average. Because this group differs from the general population in many ways it is difficult to separate the various factors that might influence their health. During 6 years of follow-up, a total of 107 deaths occurred. Based on comparison with 1977 United States whites, the standardized mortality ratio (SMR) is 78% for the males, 54% for the females, and 68% for both sexes combined. All three SMR values are significantly less than 100% ($P < 0.05$). For both sexes combined, the SMR is 86% for cancer, 62% for total cardiovascular diseases, and 73% for all other causes. Only the cardiovascular SMR is significantly lower than 100%. The death rate for the males is approximately the same as that reported among other healthy nonsmoking questionnaire respondents, but the death rate for females is significantly less ($P < 0.01$). The only notable relationships between questions asked in 1974 and subsequent mortality are those indicating a higher mortality rate associated with inactivity, heart trouble, and very low and very high levels of vitamin E intake. For this highly selected cohort, the overall "*Prevention* life-style" appears to be a healthy one, but the cohort experiences no clear reduction in total mortality because of high levels of vitamin intake *per se*.**

Little reliable epidemiological information is available on the relationship between high levels of vitamin intake and mortality. The major prospective studies have concentrated on mortality in relation to factors such as tobacco consumption, alcohol consumption, serum cholesterol, some dietary habits, or other general health practices (1–4). One early study indicated that higher-than-average dietary intake of vitamins A and C was associated with a lower mortality rate (5). One recent study showed an inverse relationship between dietary vitamin A intake and lung cancer mortality but only a small nonsignificant inverse relationship with total mortality (6). Several other recent studies indicate that dietary vitamin A intake is inversely related to lung cancer and total cancer, and it has been suggested that vitamin A analogs may reduce cancer rates (7). None of these studies analyzed dietary supplements. It has been hypothesized that supplementary vitamin C may be beneficial in the prevention and treatment of the common cold (8) and cancer (9), although negative studies have been reported (10).

The specific way in which vitamins may be causally related to cancer and other diseases is not clearly established. Nevertheless, the general public has shown great interest in this subject and the use of vitamin supplements has grown dramatically in recent years. Recent estimates indicate that up to 50% of all adults in the United States now use vitamin supplements to some extent (4), in spite of little direct evidence as to their value. For this reason alone further scientific investigation is warranted. However, such investigation is complicated by the fact that this topic has become associated over the years with speculative and anecdotal claims and counterclaims. In addition, the people who use these supplements are often experimenting with various types and quantities of vitamins as well as changing other aspects of their life-style. Consequently, it is difficult to conduct a properly controlled study.

We selected *Prevention* readers because an existing 1974 questionnaire survey was made available to us. This magazine was founded in 1950 by J. I. Rodale and now has about 2.5 million subscribers, far more than any other health-related magazine. It advocates the extensive use of dietary supplements along with other practices such as nonsmoking, exercise, and dietary moderation including reduced intake of salt, sugar, and meat. With the exception of dietary supplement usage, many of these same health and dietary practices have been advocated by other major groups (11). These readers are very health conscious and constitute a defined population in which to examine the influence of the "*Prevention* life-style," particularly vitamin supplements, on mortality. This paper is not to be construed as an endorsement of *Prevention* or its editorial policy. It is simply an attempt at analyzing a group of individuals who adhere to an unusual dietary regimen.

## METHODS

We present here our findings on a highly selected cohort of *Prevention* readers. The cohort consists of 223 men and 256 women (mostly husband and wife pairs) who completed a two-page questionnaire contained in the August 1974 issue (12) and who were California white residents and at least 65 years of age at the time they completed the questionnaire. About 20,000 completed questionnaires were mailed to Richard A. Passwater from persons of all ages and all geographic areas (13), representing about a 1% response rate of all readers at that time. Passwater forwarded to us the questionnaires from California respondents because we only had the resources to undertake a follow-up of Californians. We have further limited our attention to elderly persons because of their relatively high death rates, which are not as influenced by established risk factors such as cigarette smoking as are the death rates of middle-aged persons. The cohort was selected before mortality follow-up began.

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Abbreviations: IU, international units; RDA, recommended dietary allowances; SMR, standardized mortality ratio.

Health-related information was obtained from the August 1974 questionnaire completed by all 479 and from a May 1977 follow-up questionnaire completed by 330 (69% of the original 479 and 77% of the 430 still alive as of May 1, 1977). All 479 have now been followed for mortality as of Aug. 1, 1980: 246 (51%) signed and returned an August 1980 follow-up letter, 79 (17%) have been directly contacted by telephone and are still alive, 43 (9%) are known to be alive from contact with neighbors or other sources, 107 (22%) are known to have died between Aug. 1, 1974 and Aug. 1, 1980, and 4 (1%) did not respond to the follow-up letter and cannot be contacted directly. These last 4 have been assumed to be alive as of Aug. 1, 1980 because their last known address is currently valid according to their local post office and because death-certificate searches have not identified them as dead. Numerous sources have been used to keep track of these individuals, including the *Prevention* subscriber file, Postal Service, Department of Motor Vehicles, Registrar of Voters, Social Security Administration, neighbors, and landlords. In addition, the entire cohort has been checked against the 1974–1980 California death file to make sure no one reportedly alive appears on the file. Of the original 479 California respondents, 6 have died outside of California and 29 others are living outside of California as of Aug. 1, 1980. Death certificate copies have been obtained for the deceased persons. Because the location of everyone is known, the 6-yr follow-up can be considered 100% complete.

## RESULTS

Table 1 gives a composite picture of the cohort based on the self-reported questionnaire data collected in 1974 and 1977, along with data from other sources (14–17) on United States whites ≥65 yr old. The validity of the self-reported information has not been confirmed by detailed physical or nutritional examination. However, the age in 1974, date of birth, height, and weight agree with corresponding data on the driver's license records for the two-thirds with licenses. In 1974, the average age was 74 yr (range, 65–96 yr). In 1974, the cohort smoked about one-half as much as elderly United States whites. But only about 40% of the men and 60% of the women never smoked cigarettes, which is similar to the percentage of "never" smokers among the elderly United States whites. Their diet, cholesterol intake, and level of activity were described as about "average." Their height was about average and their weight was somewhat less than average. A total of 31% had heart trouble, compared to 20% of elderly United States whites (14). Of those 144 respondents reporting heart trouble, about 30% had angina or hypertension, about 40% had various heart problems, and about 30% had experienced a heart attack or stroke. Their urban/rural distribution was fairly similar to the national average, but their median educational level, ≈12 yr, was 3 yr above the national average. Although they are now mostly retired, the proportion that were professional, technical, or managerial persons in their usual occupation was higher than the national average (16).

About 60% drank coffee or tea and about half drank beer, wine, or liquor; these are fairly similar to the proportions among elderly United States whites. With regard to diet, the use of meat, poultry, and fish appears to be moderate with relatively few heavy users and few complete abstainers; their frequency of use is less than that of average Americans (17). Only about half used whole milk and salt, and about a third or less used white bread, sugar, and candy.

The reported use of dietary supplements by this cohort is extraordinary. Essentially all of them were consuming vitamin C and E pills and about 80% were using other supplements—mainly vitamin A and B-complex pills, multivitamins,

Table 1. Demographic and life-style characteristics of Californian respondents in 1974 and 1977 and United States whites ≥65 yr old (some numbers have been approximated)

| | | White males | | White females | |
|---|---|---|---|---|---|
| Year | Characteristic | Respondents | U.S. sample | Respondents | U.S. sample |
| 1974 | Sample size | ≤223 | Various | ≤256 | Various |
| 1977 | | ≤150 | Various | ≤180 | Various |
| 1974 | Urbanization, % in SMSAs | ≈90 | ≈75 | ≈90 | ≈75 |
| 1977 | Marital status | | | | |
| | % married | 80 | 78 | 35 | 39 |
| | % widowed | 12 | 14 | 45 | 52 |
| 1977 | Education | | | | |
| | Median, yr | 12 | 9.0 | 12 | 9.3 |
| | % <12 yr | 39 | 60 | 30 | 55 |
| 1977 | Currently in labor force, % | ≈30 | 20 | ≈20 | 8 |
| 1977 | Professional, technical, or managerial job when working, % | 38 | ≈30 | 31 | ≈10 |
| 1977 | Height (mean, without shoes), cm | 172.7 | 170.4 | 160.0 | 158.2 |
| 1977 | Weight (mean, without clothes), kg | 70.4 | 74.5 | 59.0 | 65.8 |
| 1974 | % with heart trouble | 34 | 20 | 27 | 20 |
| 1974 | Smoking status, % current smokers | 12 | 25 | 5 | 13 |
| 1977 | Cigarette smoking, % | | | | |
| | Current | 3 | 23 | 4 | 13 |
| | Former | 54 | 46 | 31 | 12 |
| | Never | 43 | 31 | 65 | 75 |
| 1977 | Cigar smokers, % current | 2 | 10 | 1 | 0 |
| 1977 | Pipe smokers, % current | 2 | 8 | 0 | 0 |
| 1977 | Beer drinking, % current | 30 | ≈40 | 18 | ≈20 |
| 1977 | Wine drinking, % current | 46 | ≈40 | 38 | ≈30 |
| 1977 | Liquor drinking, % current | 33 | ≈40 | 29 | ≈30 |
| 1977 | Coffee drinking, % current | 66 | ≈80 | 56 | ≈80 |
| 1977 | Tea drinking, % current | 54 | ≈40 | 56 | ≈40 |
| 1977 | Meat, poultry, or fish, % | | | | |
| | Never or formerly | ≈8 | 0 | ≈8 | 0 |
| | >7 times/week | ≈30 | 74 | ≈30 | 72 |
| 1977 | Whole milk, % | | | | |
| | Never or formerly | ≈48 | 22 | ≈48 | 26 |
| | >7 times/week | ≈29 | 46 | ≈29 | 39 |
| 1977 | Eggs, % | | | | |
| | Never or formerly | 4 | 5 | 8 | 9 |
| | >7 times/week | 24 | 27 | 30 | 16 |
| 1977 | Desserts, sweets, % | | | | |
| | Never or formerly | ≈63 | 6 | ≈63 | 8 |
| | >7 times/week | ≈10 | 36 | ≈10 | 33 |
| 1977 | Salt, % current | 49 | | 49 | |
| 1977 | White bread, % current | 20 | | 20 | |
| 1974 | Vitamin supplements, % current | 96 | 33 | 98 | 42 |
| 1974 | Vitamin E, daily IU* | | | | |
| | Mean | ≈500 | | ≈500 | |
| | Median | ≈450 | ≈10† | ≈450 | ≈10† |
| 1977 | Vitamin E, daily IU | | | | |
| | Mean | ≈700 | | ≈700 | |
| | Median | ≈600 | ≈10† | ≈600 | ≈10† |
| 1977 | Vitamin C, daily mg | | | | |
| | Mean | ≈1,700 | 89† | ≈1,700 | 91† |
| | Median | ≈1,300 | 72† | ≈1,300 | 78† |
| 1977 | Vitamin A, daily IU | | | | |
| | Mean | ≈18,000 | 5,500† | ≈18,000 | 5,200† |
| | Median | ≈17,000 | 3,300† | ≈17,000 | 3,000† |

* IU, international units.

† Excluding intake from vitamin supplements.

Table 2. Age and sex distributions of original (Aug. 1, 1974) cohort and of deaths up to Aug. 1, 1980

| | Males by age on Aug. 1, 1974 | | Males by attained age | | Females by age on Aug. 1, 1974 | | Females by attained age | |
|---|---|---|---|---|---|---|---|---|
| Age, yr | Alive as of 8/1/74 | Dead as of 8/1/80 | Person-yr of observation as of 8/1/80 | Dead as of 8/1/80 | Alive as of 8/1/74 | Dead as of 8/1/80 | Person-yr of observation as of 8/1/80 | Dead as of 8/1/80 |
| 65–69 | 74 | 14 | 192.2 | 6 | 90 | 6 | 256.9 | 1 |
| 70–74 | 60 | 19 | 356.4 | 13 | 71 | 8 | 445.6 | 10 |
| 75–79 | 52 | 14 | 296.7 | 20 | 50 | 6 | 358.9 | 5 |
| 80–84 | 28 | 17 | 208.7 | 17 | 33 | 9 | 230.1 | 8 |
| >85 | 9 | 6 | 87.6 | 14 | 12 | 8 | 132.4 | 13 |
| Total | 223 | 70 | 1,141.8 | 70 | 256 | 37 | 1,423.9 | 37 |

Table 3. Observed and expected deaths, Aug. 1, 1974, to Aug. 1, 1980, with corresponding SMR

| | Males | | | Females | | | Both sexes | | |
|---|---|---|---|---|---|---|---|---|---|
| Reference population | Obs. deaths | Exp. deaths | SMR, % | Obs. deaths | Exp. deaths | SMR, % | Obs. deaths | Exp. deaths | SMR, % |
| 1977 United States whites | 70 | 89.3 | 78* | 37 | 68.3 | 54‡ | 107 | 157.6 | 68‡ |
| 1970 United States whites | 70 | 96.8 | 72† | 37 | 79.5 | 47‡ | 107 | 176.3 | 61‡ |
| 1966–1968 United States whites who never smoked cigarettes | 70 | ≈84 | 83 | 37 | ≈80 | 46‡ | 107 | ≈164 | 65‡ |
| 1960–1972 American Cancer Society cohort members who never smoked regularly | 70 | ≈66 | 106 | 37 | ≈59 | 63† | 107 | ≈125 | 86 |

Expected deaths were based on the death rates for 1977 and 1970 United States whites, 1966–1968 United States whites who never smoked cigarettes, and the 1960–1972 American Cancer Society cohort members who never smoked regularly. For the difference between SMR and 100% (based on the two-tailed test for the ratio of an observed value of a Poisson variable to its expectation), $P$ values are shown as follows: *, $P < 0.05$; †, $P < 0.01$; ‡, $P < 0.001$.

wheat germ, lecithin, and minerals such as zinc and magnesium. The reported mean daily intake of vitamin E in 1974 was 500 international units (IU) for an average of 7 yr. In 1977 the average was 700 IU of vitamin E, 1.7 g of vitamin C, and 18,000 IU of vitamin A for periods averaging 10–13 yr. By contrast, in 1971–1974 United States whites ages 65–74 yr had a mean daily intake of about 90 mg of vitamin C and 5,300 IU of vitamin A, excluding intake from vitamin supplements; about 30% used vitamin supplements regularly and another 8% used them irregularly in 1971–1974 (17). The 1974 daily recommended dietary allowances (RDA) of the Food and Nutrition Board of the National Research Council were 45 mg of vitamin C, 15 IU of vitamin E, and 5,000 IU of vitamin A (18).

The only dietary questions that were similar in both the 1974 and 1977 questionnaires—namely, the amount and period of vitamin E use—show only moderate correlations ($r \approx 0.6$) between the values reported in 1974 and 1977 by the same individual. The lack of high correlation indicates substantial variation in the amount of vitamin E consumed and some lack of recall in the time of use. Obviously, the reported intakes of vitamins and minerals are imprecise and variable but nonetheless they surely exceed the RDA by many fold.

During 6 yr of follow-up, deaths were observed in 70 men and 37 women. Standard life table procedures (19) indicate that there were 1,142 male and 1,424 female person-years of observation from Aug. 1, 1974, to Aug. 1, 1980; the distribution in 5-yr age groups is shown in Table 2. The expected deaths during the 6 yr have been determined by multiplying age-specific person-years of observation by the corresponding 1977 United States white death rates (15) and summing over all age groups. Table 3 indicates the standardized mortality ratio (SMR; observed-to-expected ratio) to be 78% for males, 54% for females, and 68% for both sexes combined. For the difference between these SMR values and 100%, $P < 0.05$ for males and $P < 0.001$ for females and both sexes combined, based on the two-tailed test for the ratio of an observed value of a Poisson variable to its expectation (20). This test has been used for other comparisons in Table 2, including comparisons with 1970 United States whites.

These deaths have also been analyzed by major cause of death (Table 4). The SMR for both sexes combined is 86% for cancer, 62% for total cardiovascular diseases, and 73% for all other causes. Only the SMR for total cardiovascular diseases is significantly less than 100% ($P < 0.001$).

In interpreting these ratios, it should be noted that during the first year of follow-up the SMR was only 31%, but during the first 3 yr it was 68% and during the last 3 yr it was 68%. The large reduction in the first year, based on only eight deaths, was most likely due to the fact the people were all healthy enough to fill out the questionnaire in 1974. But since an overall low ratio persisted for each of the 6 yr and the cumulative ratio remained stable during the last 4 yr, the reduction is only partially influenced by their initial health status. Obviously, this cohort is very self-selected and it is important to determine if they are different from other self-selected questionnaire respondents. The American Cancer Society prospective study consisted of 1 million upper-middle-class whites from 25 states and is the largest epidemiologic cohort study ever conducted (1, 22). These individuals were noninstitutionalized and were generally healthy at the time they completed their questionnaire, around Jan. 1, 1960 (1), and they were followed for mortality for 12 yr (22). About 23,000 men and 85,000 women were at least 65 yr old

Table 4. Observed and expected deaths by major cause from Aug. 1, 1974, to Aug. 1, 1980, with SMR

| | | Males | | | Females | | | Both sexes | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Cause of death | ICDA8* | Obs. deaths | Exp. deaths | SMR, % | Obs. deaths | Exp. deaths | SMR, % | Obs. deaths | Exp. deaths | SMR, % |
| Cancer | 140–209 | 15 | 16.2 | 93 | 8 | 10.6 | 75 | 23 | 26.8 | 86 |
| Total cardiovascular diseases | 390–458 | 41 | 54.8 | 75 | 21 | 45.8 | 46‡ | 62 | 100.6 | 62‡ |
| All other causes | | 14 | 18.3 | 77 | 8 | 11.9 | 67 | 22 | 30.2 | 73 |
| Total | | 70 | 89.3 | 78† | 37 | 68.3 | 54‡ | 107 | 157.6 | 68‡ |

Expected deaths were based on death rates for 1977 United States whites. For the difference between SMR and 100%, $P$ values are shown as follows: †, $P < 0.05$; ‡, $P < 0.001$.

* See ref. 21.

and never had smoked regularly. The American Cancer Society "never-smoker" cohort ranks among the healthiest groups ever studied in terms of low mortality and high life expectancy (23). The SMR of the *Prevention* cohort relative to these never-smokers is 106% for males and 63% for females. In another comparison, the SMR of the *Prevention* cohort relative to a representative sample of 1966–1968 United States whites who never smoked cigarettes is 83% for males and 46% for females (24). The female SMR values in all the above comparisons are less than 100% at $P < 0.01$. In other words, the female *Prevention* questionnaire respondents have death rates that are statistically significantly lower than those of both nonsmoking women as a whole and healthy nonsmoking female questionnaire respondents in a well-known prospective study.

In order to investigate the possibility that vitamin supplement use is responsible for the relatively low death rates in this cohort, vitamin supplement users and nonusers who are similar in other respects should be compared. But, because there were very few nonusers in our cohort, this comparison cannot be done properly. However, by using 1974 questionnaire data it is possible to examine the relationship of mortality rate to vitamin E intake at levels far above the 1974 RDA of 15 IU. No dose–response relationship is apparent for either the period of vitamin E use or the daily intake of vitamin E between 100 and 999 IU (Table 5). The death rate among the 14 nonusers of vitamin E is double the rate for the 465 users, but the difference is not quite statistically significant ($P = 0.06$). The death rate for 51 users of vitamin E at ≥1,000 IU is about double the rate for the three categories of users between 100 and 999 IU, and this difference is significant ($P = 0.02$). No significant differences ($P < 0.05$) in death rates exist between the users and nonusers of the other nutritional supplements (such as multivitamins, wheat germ, and lecithin) in the 1974 questionnaire, or between smokers and nonsmokers. Even persons who thought that they were helped by vitamin E experienced no lower mortality rate. Highly significant mortality differences did exist with respect to level of activity ($P < 0.0001$) and presence of heart trouble ($P = 0.002$), which are two indicators of the 1974 health status of the respondents. Since the vitamin E usage is about 20% higher in persons with existing heart trouble, we have examined separately the 308 vitamin E users who reported never having heart trouble (Table 5). Again, the death rate is about double for 27 users at ≥1,000 IU, but this difference was not significant ($P = 0.07$). With our small sample size it is not possible to examine these relationships in any more detail.

Data on vitamins A and C were first collected on the May 1977 follow-up questionnaire. However, responses to the 1977 vitamin questions were obtained from only about half of the original 1974 cohort, and hence these data are of limited value. No significant differences ($P < 0.05$) in the subsequent death rates exist with respect to 1977 cigarette smoking status or level of intake of vitamins A, C, and E, although there is a consistent tendency for the rates to increase with the levels of vitamin intake (Table 6). However, the death rates at the highest vitamin intake level are still below the expected 1977 United States white death rate.

Table 5. Death rate in subgroups of respondents: Proportion dying from Aug. 1, 1974, to Aug. 1, 1980, classified according to August 1974 questionnaire responses*

| | Persons | Deaths | Proportion dead† |
|---|---|---|---|
| Total expected deaths | 479 | 157.6 | 0.33 |
| Total observed deaths | 479 | 107 | 0.22 |
| Vitamin E supplement use: | | | |
| Yes | 465 | 101 | 0.22 |
| No | 14 | 6 | 0.43 |
| Estimated dose, IU daily | | | |
| 100–299 | 134 | 25 | 0.19 |
| 300–499 | 131 | 27 | 0.21 |
| 500–999 | 130 | 29 | 0.22 |
| ≥1,000 | 51 | 20 | 0.39‡ |
| Period of use, yr | | | |
| 1–4 | 203 | 45 | 0.22 |
| 5–9 | 133 | 23 | 0.17 |
| ≥10 | 118 | 31 | 0.26 |
| Helped by vitamin E: | | | |
| Yes | 312 | 68 | 0.22 |
| No | 51 | 9 | 0.18 |
| Unknown | 116 | 30 | 0.26 |
| Multivitamin use: | | | |
| Yes | 368 | 79 | 0.21 |
| No | 98 | 27 | 0.28 |
| Wheat germ use: | | | |
| Yes | 374 | 74 | 0.21 |
| No | 111 | 26 | 0.23 |
| Lecithin use: | | | |
| Yes | 375 | 83 | 0.22 |
| No | 81 | 17 | 0.21 |
| Smoking: | | | |
| Yes | 45 | 12 | 0.27 |
| No | 430 | 94 | 0.22 |
| Level of activity: | | | |
| Very active | 102 | 11 | 0.11 |
| Active | 42 | 3 | 0.07 |
| Normal | 246 | 62 | 0.25 |
| Inactive | 39 | 10 | 0.26 |
| Very inactive | 37 | 17 | 0.46‡ |
| Heart trouble: | | | |
| Yes | 144 | 45 | 0.31‡ |
| No | 328 | 60 | 0.18 |
| No heart trouble, by vitamin E dose (IU daily) | | | |
| 100–299 | 92 | 16 | 0.17 |
| 300–499 | 101 | 15 | 0.15 |
| 500–999 | 88 | 18 | 0.20 |
| ≥1,000 | 27 | 10 | 0.37 |

* Persons who did not respond to individual questions (classified as "unknown") have been omitted from comparisons and statistical tests involving those questions. "Total expected deaths" is 1977 United States white death rate (see Table 3).

† Not age- or sex-adjusted because the variables analyzed were not particularly age- or sex-dependent in this cohort.

‡ Statistically significant difference ($P < 0.05$) exists in the proportions dead among the various categories of respondents based on the standard $\chi^2$ contingency table test.

## DISCUSSION

A well-defined cohort of 479 elderly respondents to a questionnaire in *Prevention* has been followed for 6 yr. Their observed mortality rate, especially for females, is substantially lower than that among elderly United States whites as a whole and among elderly nonsmoking questionnaire respondents in a major prospective epidemiologic study. It is not clear why the women had relatively lower mortality than the men. Possibly the men had poorer initial health or poorer health habits, or possibly the difference is statistical fluctuation due to small numbers. No dose–response relationship can be demonstrated between most levels of vitamin supplement usage and mortality, although the mortality rate appears to increase at the lowest and highest levels of vitamin E intake. Inactivity and heart trouble are strongly associated with increased mortality. This study lacks a proper control group of nonusers of supplements and not enough is known about the initial health status of cohort members. Although the results of this study cannot be generalized

Table 6. Death rate in subgroups of respondents alive on May 1, 1977: Proportion dying during May 1, 1977, to Aug. 1, 1980, classified according to May 1977 questionnaire responses*

| | Persons | Deaths | Proportion dead†‡ |
|---|---|---|---|
| Total expected deaths | 430 | 86.8 | 0.20 |
| Total observed deaths | 430 | 58 | 0.13 |
| Cigarette smoking: | | | |
| Current | 14 | 3 | 0.21 |
| Former | 120 | 17 | 0.14 |
| Never | 172 | 15 | 0.09 |
| Unknown | 124 | 23 | 0.19 |
| Vitamin supplement use: | | | |
| Vitamin E, IU daily: | | | |
| 100–499 | 131 | 9 | 0.07 |
| 500–999 | 79 | 10 | 0.13 |
| ≥1,000 | 72 | 13 | 0.18 |
| Unknown | 148 | 26 | 0.18 |
| Vitamin E, yr used: | | | |
| 1–9 | 103 | 17 | 0.17 |
| 10–19 | 82 | 7 | 0.09 |
| ≥20 | 34 | 6 | 0.18 |
| Unknown | 211 | 28 | 0.13 |
| Vitamin C, mg daily: | | | |
| 100–999 | 120 | 12 | 0.10 |
| 1,000–1,999 | 83 | 8 | 0.10 |
| ≥2,000 | 81 | 14 | 0.17 |
| Unknown | 146 | 24 | 0.16 |
| Vitamin C, yr used: | | | |
| 1–9 | 90 | 14 | 0.16 |
| 10–19 | 94 | 10 | 0.11 |
| ≥20 | 63 | 8 | 0.13 |
| Unknown | 183 | 26 | 0.14 |
| Vitamin A, IU daily: | | | |
| 1,000–9,999 | 34 | 2 | 0.06 |
| 10,000–19,999 | 103 | 12 | 0.12 |
| ≥20,000 | 83 | 14 | 0.17 |
| Unknown | 210 | 30 | 0.14 |
| Vitamin A, yr used: | | | |
| 1–9 | 85 | 15 | 0.18 |
| 10–19 | 59 | 4 | 0.07 |
| ≥20 | 34 | 5 | 0.15 |
| Unknown | 252 | 34 | 0.13 |

* Persons who did not respond to individual questions (classified as "unknown") have been omitted from statistical tests involving those questions. The 49 deaths before May 1, 1977, have been omitted. "Total expected deaths" as in Table 5.

† Not age- or sex-adjusted because the variables analyzed were not particularly age- or sex-dependent in this cohort.

‡ No statistically significant differences ($P < 0.05$) exist in the proportions dead among the various categories of respondents based on the standard $\chi^2$ contingency table test.

to others following this lifestyle, it can be concluded that this one group of elderly individuals does experience overall good health, even though it includes a large percentage of former smokers and persons with heart trouble. It seems to us that the "*Prevention* life-style" deserves more investigation in future epidemiologic studies, but it is not possible to conclude from this study that vitamin supplement usage *per se* has any clear beneficial effect. The purpose of this small study is to document in an epidemiological manner the mortality experience of a highly selected group of vitamin supplement users. A proper evaluation of this life-style must await the results of a larger and more carefully controlled study.

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