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Healthy lifestyle behaviors and all-cause mortality among adults in the United States[☆]

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Abstract

Objective—To examine the links between three fundamental healthy lifestyle behaviors (not smoking, healthy diet, and adequate physical activity) and all-cause mortality in a national sample of adults in the United States.

Method—We used data from 8375 U.S. participants aged 20 years of the National Health and Nutrition Examination Survey 1999–2002 who were followed through 2006.

Results—During a mean follow-up of 5.7 years, 745 deaths occurred. Compared with their counterparts, the risk for all-cause mortality was reduced by 56% (95% confidence interval [CI]: 35%–70%) among adults who were nonsmokers, 47% (95% CI: 36%, 57%) among adults who were physically active, and 26% (95% CI: 4%, 42%) among adults who consumed a healthy diet. Compared with participants who had no healthy behaviors, the risk decreased progressively as the number of healthy behaviors increased. Adjusted hazard ratios and 95% confidence interval were 0.60 (0.38, 0.95), 0.45 (0.30, 0.67), and 0.18 (0.11, 0.29) for 1, 2, and 3 healthy behaviors, respectively.

Conclusion—Adults who do not smoke, consume a healthy diet, and engage in sufficient physical activity can substantially reduce their risk for early death.

[☆]Disclaimer: The findings and conclusions in this article are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

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Conflicts of interest statement

The authors declare that there are no conflicts of interest.

Keywords

Diet; Exercise; Health behavior; Mortality; Prospective studies; Smoking

Introduction

The Alameda County Study was instrumental in identifying a constellation of health-related practices, which became known as the Alameda 7 and included never smoking, physical activity, moderate or no alcohol consumption, average weight, sleeping seven or eight hours per night, eating breakfast, and not snacking between meals (Belloc and Breslow, 1972). Since then, a growing body of research has examined the combined effects of different sets of healthy lifestyle behaviors on health outcomes such as all-cause mortality, life-expectancy, cardiovascular disease, stroke, diabetes, and cancer. Generally, these studies have found that people who maximize the number of healthy lifestyle behaviors have a substantially reduced risk for developing chronic disease morbidity or mortality compared to those who have no healthy lifestyle behaviors. However, relatively few of these studies have examined all-cause mortality as the principal outcome (Haveman-Nies et al., 2002; Khaw et al., 2008; King et al., 2007; Knuops et al., 2004; Kvaavik et al., 2010; Nechuta et al., 2010; Spencer et al., 2005; Tamakoshi et al., 2009; van Dam et al., 2008; Wingard et al., 1982). Given the trends in risk factors and other secular changes that may affect health, periodic assessment of the risks attributable to lifestyle behaviors using recent data is clearly very important. Therefore, the objective of this study was to examine the risks for mortality from all-causes, major cardiovascular diseases, cancer, and other causes in relation to the number of healthy lifestyle behaviors (not smoking, good dietary practice, and adequate physical activity) among adults in the United States. We selected these three behaviors because they are key behaviors that have been shown to exact a huge toll on morbidity and mortality for chronic disease (Danaei et al., 2009; McGinnis and Foege, 1993; Mokdad et al., 2004).

Methods

We used the public data files for the 2006 follow-up of participants of the 1999–2000 and 2001–2002 cycles of the National Health and Nutrition Examination Survey (NHANES). The samples were selected by using a multistage, stratified sampling design and constitute representative samples of the noninstitutionalized civilian US population (Centers for Disease Control and Prevention, 2009a). Participants were interviewed at home and invited for a clinical examination. Details about the NHANES and its methods have been published. The interview response rates were 82% for 1999–2000 and 84% for 2001–2002, and the examination response rates were 76% and 80%, respectively. The study received approval from the National Center for Health Statistics Research Ethics Review Board, and participants were asked to sign an informed consent form.

The mortality status of participants aged 20 years through 2006 was determined by using the National Death Index (Centers for Disease Control and Prevention, 2010). The National Death Index identifies over 90% of deaths (Calle and Terrell, 1993; Edlavitch and Baxter, 1988; Stampfer et al., 1984). Participants who were not deemed to have died as of December

31, 2006 were considered to be alive. Using the 113 categories of underlying causes of death that were included on the public use files, we grouped deaths into the following major categories of death: major cardiovascular diseases (International Classification of Diseases, 10th Revision (ICD-10) I00–I78), malignant neoplasms (ICD-10C00–C97), and all other causes of death.

Three behaviors of interest were included: smoking, diet, and physical activity. Information about smoking and physical activity was obtained during the home interview. At the mobile examination center, dietary information was obtained with a single 24-hour recall. Not smoking, consuming a healthy diet, and engaging in adequate physical activity were considered healthy or low-risk behaviors. A nonsmoker was defined as a participant who had never smoked (had never smoked ≥ 100 cigarettes during his or her life) or who had quit smoking (had smoked ≥ 100 cigarettes and was not smoking at the time of inquiry). Participants who were currently smoking (had smoked ≥ 100 cigarettes and were smoking at the time of inquiry) were the high-risk counterparts.

Participants were asked about the frequency and duration of participation in moderate and vigorous physical activity during the past 30 days. Participants were deemed to be adequately active if the participant engaged in 150 or more minutes of moderate or vigorous activity per week (U.S. Department of Health and Human Services, 2008). To calculate the total number of weekly physical activity minutes, the minutes of vigorous physical activity were multiplied by 2.

We used the Healthy Eating Index score as our indicator of dietary behavior (Kennedy et al., 1995). The Healthy Eating Index has 10 subcomponents each with a score ranging from 0 to 10: grains, fruits, vegetables, dairy, meats, fats, saturated fat, cholesterol, sodium, and variety. Participants in the top 40% of the Healthy Eating Index were considered to show evidence of a healthy dietary pattern.

We included age, gender, race or ethnicity, educational status, alcohol consumption, energy intake, and self-reported histories of cardiovascular disease (myocardial infarction, stroke, or congestive heart failure), cancer, and diabetes in the analyses. All information for these study variables was obtained via questionnaire. Alcohol consumption was determined from a single 24-hour dietary recall.

Statistical analyses

The analyses were limited to participants aged ≥ 20 years. We excluded pregnant women from the analyses. Differences in percentages and means were tested with chi-square tests and t-tests, respectively. Orthogonal polynomial contrasts were used to test for linear trend. We used proportional hazard regression analysis to examine the independent association between individual and multiple health behaviors and mortality. Time in months was defined from the date of study entry until date of death or end of study on December 31, 2006. Schoenfeld residuals were used to test proportionality assumptions which were not deemed to have been violated. Population attributable fractions for the study outcomes were calculated using the formula $1 - 1 / \sum_{i=0}^k (p_i RR_i)$ where p_i represents the proportion for

each level of the number of low risk lifestyle factors ($i = 0$ through $i = k$) and RR_i is the corresponding hazard ratio for the i th level compared with the reference level. In analyses testing for interactions by race or ethnicity between lifestyle behaviors and outcomes, participants with two or three healthy behaviors were combined. To account for the complex sampling design of the survey, analyses were conducted with SUDAAN.

Results

A total of 9471 participants attended the mobile examination center between 1999 and 2002; 9461 of them were eligible for follow-up. Excluding pregnant women reduced the sample size to 8880. After participants with missing data for study variables were excluded, 8375 participants were included in the principal analyses. These participants included 4197 men and 4178 women, 4098 whites, 1604 African Americans, 1986 Mexican Americans, and 687 adults of another race or ethnicity.

At baseline, 12.6% of participants had zero healthy behaviors, 34.8% had 1, 36.6% had 2, and 15.9% had three healthy behaviors. Women and men had a similar unadjusted distribution of healthy behaviors ($p = 0.141$). However, the unadjusted distribution of the number of healthy behaviors differed by race or ethnicity (Whites: 12.4%, 32.8%, 36.9%, 18.0%; African Americans: 15.8%, 44.8%, 31.1%, 8.2%; Mexican Americans: 11.7%, 39.8%, 37.4%, 11.1%, respectively; $p < 0.001$).

During a mean follow-up time of 5.7 years, there were 745 deaths. A number of baseline characteristics differed according to mortality status (Table 1). Survivors tended to be more likely to be a nonsmoker and were more likely to consume a healthy diet, to be adequately active, and to have three healthy behaviors. Across the number of healthy behaviors, significant trends were present for mean age, mean alcohol intake, mean waist circumference, percentage of participants who were white, percentage of participants with an education beyond high school, and percentages of participants who had cardiovascular disease or diabetes (Table 2).

Compared with their counterparts, the risk for all-cause mortality was reduced by 56% among adults who were nonsmokers, 47% among adults who were physically active, and 26% among adults who consumed a healthy diet (Table 3). Adults, who were nonsmokers or who were adequately active, also showed large reductions in mortality from major cardiovascular diseases, cancer, and other causes.

The risks for mortality from all-causes, cardiovascular disease, cancer, and other causes decreased progressively as the number of healthy behaviors increased (Table 3). Compared with participants who had no healthy behaviors, those with all three healthy behaviors had a risk for mortality from all-causes that was 82% lower, from cardiovascular disease that was 65% lower, from cancer that was 83% lower, and from other causes that was 90% lower.

There was no statistical evidence that the hazard ratios differed by gender (p -values for interaction: all-cause mortality = 0.679; cardiovascular disease mortality = 0.140; cancer mortality = 0.150; mortality from other causes = 0.281) or among the three major racial or

ethnic groups (p-values for interaction: all-cause mortality = 0.088; cardiovascular disease mortality = 0.202; cancer mortality = 0.586; mortality from other causes = 0.441).

To examine the possibility of reverse causality, we created an additional model after excluding participants who died during the first year of follow-up (Table 4). The results for all-cause-mortality were very similar to those in Table 3. In addition, we also reran the analysis after excluding participants with self-reported cardiovascular disease, cancer, and diabetes. A strong inverse gradient of risk was again evident.

To calculate the population attributable fraction, we inverted the healthy index to estimate hazard ratios. The population attributable fraction was about 67% suggesting that a large percentage of deaths could have been avoided during the approximately 5-year follow-up period if the mortality rates of participants with 1, 2, and 3 unhealthy behaviors could have been reduced to the rate of participants with all healthy behaviors. The population attributable fractions for major cardiovascular diseases, cancer, and other causes of death were 48%, 69%, and 79%, respectively.

When the combinations of the three healthy behaviors were examined as eight mutually exclusive categories, considerable variation in the adjusted hazard ratios was present (Table 5). Of the three individual healthy behaviors, only the adjusted hazard ratio for nonsmoking was significantly lower. Of the combinations of two healthy behaviors, the combination of nonsmoking and adequate physical activity yielded the smallest adjusted hazard ratio. The magnitude of the hazard ratio for all three healthy behaviors was the smallest. However, the 95% confidence interval overlapped considerably with that of the next smallest estimate which was the combination of nonsmoking and adequate physical activity. Because the number of deaths in at least one category was small, we refrained from pursuing additional analyses related to the other endpoints or stratified by demographic variables.

Discussion

Our results show that three cardinal lifestyle behaviors exerted an enormous impact on mortality. Of the three healthy behaviors, non-smoking and adequate physical activity showed the largest reductions in all-cause mortality. Our results powerfully underscore the importance of continued efforts by public health practitioners and health care providers to reduce the prevalence of smoking, improve diets, and improve the level of physical activity among adults in the United States.

Only a few studies have looked at the relationship between the three healthy factors included in the present study and all-cause mortality. In the SENECA study, men and women aged 70–75 years who smoked, were inactive, and had a low-quality diet had three to four times higher all-cause mortality compared with participants who did not smoke, were active, and had a high-quality diet (Haveman-Nies et al., 2002).

The powerful relationship between the three healthy behaviors and mortality argues for the need to effect improvements in these healthy behaviors in the U.S. population. Although a great deal of progress in reducing the prevalence of smoking in the United States since 1964

has been achieved, progress since 2004 has been slow (Centers for Disease Control and Prevention, 2009b).

A large percentage of the United States population is not adequately active (U.S. Department of Health and Human Services, 2011). However, the percentage of middle aged and older adults who met current guidelines for aerobic activity and muscle-strengthening increased slightly from 1999 to 2009 (U.S. Department of Health and Human Services, 2011). Improving the diet of the U.S. population remains a major challenge. Favorable progress was booked in some areas such as saturated fat consumption (Wright et al., 2004), but a lack of progress defined other areas such as total energy intake or the consumption of fruits and vegetables (Blanck et al., 2008; Harnack et al., 2000; Wright and Wang, 2010).

Studies have consistently shown that fewer than 20% of adults engage in multiple healthy behaviors depending on the number of behaviors included in the index (Akesson et al., 2007; Chiuve et al., 2006; Ford et al., 2001, 2010; Haveman-Nies et al., 2002; Hu et al., 2001; King et al., 2007; Knuops et al., 2004; Metzner et al., 1983; Pronk et al., 2004; Schoenborn, 1986; Stampfer et al., 2000; Tamakoshi et al., 2009). These healthy behaviors substantially delay death, as shown in our study and those of others. Substantial gains in life expectancy might therefore be achievable if, in the future, larger percentages of the population are able to achieve low-risk status for all three lifestyle behaviors. Under the rubric of “it is never too late”, an analysis of data from Atherosclerosis Risk in Communities Study showed that adults who adopted healthy behaviors during middle age reduced their risk for subsequent mortality (King et al., 2007). Several studies with elderly participants also showed that those with the maximum number of healthy behaviors had the lowest mortality rate (Haveman-Nies et al., 2002; Knuops et al., 2004; Spencer et al., 2005).

Our study is subject to several limitations. The data for all three behaviors was obtained through self-report and, therefore, is subject to some degree of misclassification. If people who had a high-risk behavior falsely reported having a healthy behavior, it is likely that the hazard ratios may have been underestimated. Vital status of participants was assessed by matching the cohort to the National Death Index allowing the possibility of some error. The number of deaths proved to be too small for detailed cause-specific analyses and various stratified analyses. Of the three healthy behaviors, the dichotomized Healthy Eating Index score was the weakest predictor of mortality, which may be partially attributable to the fact that the Healthy Eating Index score was determined from a single 24-hour dietary recall. Reverse causality may have played a role in producing the observed results. Finally, participants may have changed behaviors during the follow-up period. The extent of any change that might have occurred and the direction of any change are unknown. Thus, we were unable to estimate the impact of change in behaviors on risk estimates.

In conclusion, a strong dose–response relationship existed between the number of healthy lifestyle behaviors and reductions in mortality in a national sample of adults in the United States. These data show that refraining from smoking, eating a healthy diet, and being adequately active can greatly reduce mortality over the short to medium term. Our results provide strong empirical support for current efforts to improve the health of the population

in the United States through targeted public health efforts at improving the behavioral risk profile of adults.

Abbreviations

aHR	adjusted hazard ratio
CI	confidence interval
ICD	International Classification of Diseases
NHANES	National Health and Nutrition Examination Survey

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Table 1

Age-adjusted baseline characteristics among 8375 United States adults aged 20 years, by mortality status, National Health and Nutrition Examination Survey 1999–2002.

Characteristics	Total (n=8375)	Deceased (n=745)	Survivors (n=7630)	P
	Mean or % (95% CI)	Mean or % (95% CI)	Mean or % (95% CI)	
Age (years)	45.6 (44.9, 46.3)	66.9 (64.7, 69.0)	44.3 (43.7, 45.0)	<0.001
Men, %	48.8 (47.7, 49.8)	63.1 (54.8, 70.7)	48.1 (46.9, 49.3)	0.001
Whites, %	72.0 (68.2, 75.6)	66.8 (55.6, 76.3)	72.2 (68.3, 75.8)	0.251
>High school, %	52.3 (49.5, 55.1)	34.6 (28.4, 41.4)	53.0 (50.2, 55.8)	<0.001
Alcohol intake (g)	11.3 (9.9, 12.7)	11.4 (4.8, 18.0)	11.3 (9.9, 12.7)	0.981
Energy intake (kcal/day)	2193.8 (2161.4, 2226.1)	2293.6 (2101.6, 2485.6)	2193.0 (2161.7, 2224.4)	0.284
Body mass index (kg/m ²)	28.0 (27.7, 28.3)	28.7 (26.9, 30.4)	28.0 (27.7, 28.3)	0.463
Waist circumference (cm)	95.8 (95.1, 96.5)	99.4 (96.0, 102.7)	95.7 (95.0, 96.5)	0.034
History of cardiovascular disease, %	8.6 (7.8, 9.6)	27.1 (19.5, 36.4)	7.6 (6.8, 8.5)	<0.001
History of cancer, %	8.2 (7.5, 9.0)	15.1 (10.4, 21.5)	7.7 (7.0, 8.5)	0.013
Diagnosed diabetes, %	6.8 (6.1, 7.6)	19.7 (13.0, 28.8)	6.2 (5.5, 7.0)	0.002
Not smoked, %	75.7 (73.8, 77.5)	63.3 (49.5, 75.1)	76.3 (74.4, 78.2)	0.060
Healthy diet, %	40.0 (37.4, 42.7)	21.6 (15.9, 28.6)	40.5 (37.8, 43.2)	<0.001
Physically active, %	40.5 (37.6, 43.4)	23.2 (14.8, 34.4)	41.4 (38.5, 44.5)	0.001
Number of low-risk behaviors				<0.001
0	12.5 (11.1, 14.0)	25.9 (15.2, 40.6)	12.0 (10.7, 13.6)	
1	34.8 (32.9, 36.9)	42.4 (33.3, 52.0)	34.4 (32.3, 36.5)	
2	36.8 (35.5, 38.0)	29.4 (20.9, 39.7)	36.9 (35.7, 38.1)	
3	15.9 (13.7, 18.5)	2.3 (1.4, 3.5)	16.7 (14.4, 19.4)	

Sample sizes for body mass index and waist circumference were 8103 and 8094, respectively.

Table 2

Age-adjusted baseline characteristics among 8375 United States adults aged ≥ 20 years, by the number of low-risk behaviors, National Health and Nutrition Examination Survey 1999–2002.

Characteristics	Number of low-risk behaviors				P
	0 (n=998)	1 (n=3092)	2 (n=3125)	3 (n=1160)	
	Mean or % (95% CI)	Mean or % (95% CI)	Mean or % (95% CI)	Mean or % (95% CI)	
Age (years)	41.9 (40.8, 43.0)	45.2 (44.3, 46.1)	46.9 (45.7, 48.0)	46.4 (44.8, 48.1)	<0.001
Men, %	52.4 (49.0, 55.7)	47.6 (45.2, 50.0)	49.4 (47.2, 51.6)	48.0 (45.4, 50.6)	0.065
Whites, %	70.7 (64.7, 76.0)	68.1 (63.7, 72.2)	72.1 (67.8, 76.1)	80.7 (76.4, 84.3)	0.002
>High school, %	31.0 (26.0, 36.4)	42.8 (40.2, 45.6)	60.0 (57.4, 62.5)	73.5 (69.5, 77.2)	<0.001
Alcohol consumption (g)	15.8 (11.8, 19.9)	10.9 (9.5, 12.3)	10.4 (8.4, 12.4)	10.1 (7.8, 12.3)	0.010
Energy intake (kcal/day)	2094.9 (2006.3, 2183.6)	2147.1 (2103.9, 2190.3)	2229.5 (2179.4, 2279.6)	2283.5 (2229.4, 2337.5)	<0.001
Body mass index (kg/m ²)	26.8 (26.3, 27.3)	29.0 (28.6, 29.4)	28.0 (27.7, 28.4)	26.6 (26.2, 27.0)	0.147
Waist circumference (cm)	94.9 (93.4, 96.4)	98.0 (97.0, 98.9)	95.7 (94.9, 96.5)	92.1 (90.9, 93.2)	0.001
History of cardiovascular disease, %	13.0 (10.4, 16.1)	8.6 (7.5, 9.9)	8.0 (6.8, 9.4)	6.9 (5.6, 8.5)	<0.001
History of cancer, %	8.4 (6.0, 11.7)	8.6 (7.7, 9.7)	8.2 (7.2, 9.3)	6.8 (5.5, 8.4)	0.292
Diagnosed diabetes, %	7.1 (5.0, 9.9)	7.6 (6.5, 8.8)	7.2 (6.1, 8.4)	4.4 (3.3, 5.8)	0.037

Sample sizes for body mass index and waist circumference were 8103 and 8094, respectively.

Table 3

Sample sizes, rates, and hazard ratios for mortality from all-causes, major cardiovascular disease, cancer, and other causes of death among United States participants aged ≥ 20 years, National Health and Nutrition Examination Survey 1999–2006.

	Not currently smoking	Top 40% of HEI score	Physically active	Number of low-risk behaviors			
				0	1	2	3
<i>All-causes</i>							
No. deaths/no. at risk				95/998	319/3092	285/3125	46/1160
Age-adjusted rate/1000 PY (95% CI)				18.6 (10.8, 26.3)	13.7 (11.5, 16.0)	10.4 (9.1, 11.8)	3.8 (2.8, 4.8)
Adjusted hazard ratios (95% CI)*	0.44 (0.31, 0.65)	0.77 (0.60, 1.01)	0.49 (0.40, 0.61)	1.00	0.60 (0.39, 0.92)	0.46 (0.31, 0.68)	0.17 (0.11, 0.28)
Adjusted hazard ratios (95% CI)†	0.44 (0.30, 0.65)	0.74 (0.58, 0.96)	0.53 (0.43, 0.64)	1.00	0.60 (0.38, 0.95)	0.45 (0.30, 0.67)	0.18 (0.11, 0.29)
<i>Major cardiovascular disease</i>							
No. deaths/no. at risk				24/998	123/3092	98/3125	19/1160
Age-adjusted rate/1000 PY				5.2 (1.3, 9.2)	4.9 (3.7, 6.0)	3.0 (2.2, 3.7)	1.7 (0.9, 2.6)
Adjusted hazard ratios (95% CI)*	0.41 (0.22, 0.73)	0.95 (0.62, 1.46)	0.48 (0.30, 0.77)	1.00	0.78 (0.39, 1.53)	0.50 (0.24, 1.04)	0.33 (0.12, 0.87)
Adjusted hazard ratios (95% CI)†	0.40 (0.22, 0.71)	0.89 (0.57, 1.38)	0.54 (0.35, 0.85)	1.00	0.78 (0.40, 1.54)	0.47 (0.23, 0.96)	0.35 (0.14, 0.88)
<i>Cancer</i>							
No. deaths/no. at risk				29/998	78/3092	68/3125	13/1160
Age-adjusted rate/1000 PY (95% CI)				6.2 (2.5, 9.9)	3.8 (2.5, 5.2)	3.0 (2.0, 4.0)	1.0 (0.5, 1.5)
Adjusted hazard ratios (95% CI)*	0.40 (0.23, 0.69)	0.82 (0.50, 1.34)	0.52 (0.33, 0.83)	1.00	0.58 (0.29, 1.19)	0.46 (0.24, 0.87)	0.17 (0.07, 0.42)
Adjusted hazard ratios (95% CI)†	0.40 (0.22, 0.73)	0.83 (0.53, 1.30)	0.54 (0.33, 0.88)	1.00	0.58 (0.27, 1.24)	0.46 (0.23, 0.92)	0.17 (0.07, 0.45)
<i>Other</i>							
No. deaths/no. at risk				42/998	118/3092	119/3125	14/1160
Age-adjusted rate/1000 PY (95% CI)				7.1 (2.3, 11.9)	5.1 (4.0, 6.1)	4.5 (3.4, 5.5)	1.0 (0.5, 1.6)
Adjusted hazard ratios (95% CI)*	0.51 (0.28, 0.92)	0.64 (0.46, 0.89)	0.48 (0.32, 0.73)	1.00	0.51 (0.29, 0.89)	0.46 (0.24, 0.87)	0.10 (0.06, 0.17)
Adjusted hazard ratios (95% CI)†	0.50 (0.27, 0.91)	0.62 (0.45, 0.85)	0.51 (0.34, 0.76)	1.00	0.49 (0.28, 0.86)	0.43 (0.23, 0.83)	0.10 (0.06, 0.16)

CI = confidence interval; HEI = Healthy Eating Index; PY = person-years.

* Adjusted for age, gender, race or ethnicity, educational attainment, alcohol consumption, and energy intake.

† Adjusted for age, gender, race or ethnicity, educational attainment, alcohol consumption, energy intake, and histories of diabetes, cardiovascular disease, and cancer.

Table 4

Sample sizes, rates, and hazard ratios for mortality from all-causes among United States participants aged 20 years, National Health and Nutrition Examination Survey 1999–2006.

	Not currently smoking	Top 40% of HEI score	Physically active	Number of low-risk behaviors			
				0	1	2	3
<i>Delete deaths in first year</i>							
No. deaths/n o. at risk				211/1817	259/3182	172/2549	20/744
Age-adjusted rate/ 1000 PY (95% CI)				16.1 (13.0, 19.2)	10.8 (9.1, 12.4)	7.4 (5.6, 9.1)	3.4 (1.7, 5.1)
Adjusted hazard ratios (95% CI)	0.42 (0.29, 0.61)	0.80 (0.61, 1.05)	0.50 (0.40, 0.64)	1.00	0.55 (0.34, 0.89)	0.46 (0.30, 0.69)	0.17 (0.10, 0.27)
<i>Delete prevalent diabetes, cancer, and cardiovascular disease</i>							
No. deaths/n o. at risk				87/1309	104/2397	84/1986	5/618
Age-adjusted rate/ 1000 PY (95% CI)				11.7 (8.4, 15.0)	7.3 (5.4, 9.2)	6.1 (4.2, 8.0)	1.4 (0.1, 2.6)
Adjusted hazard ratios (95% CI)	0.36 (0.23, 0.56)	0.66 (0.47, 0.94)	0.55 (0.37, 0.83)	1.00	0.53 (0.31, 0.92)	0.38 (0.23, 0.63)	0.13 (0.08, 0.22)

CI = confidence interval; HEI = Healthy Eating Index; PY = person-years.

Adjusted for age, gender, race or ethnicity, educational attainment, alcohol consumption, and energy intake.

Table 5

Adjusted hazard ratios (95% confidence interval) for mortality from all-causes among 8375 United States participants aged ≥ 20 years, by combinations of healthy behaviors, National Health and Nutrition Examination Survey 1999–2002 Linked Mortality Study.

Not currently smoking	Healthy diet	Adequate physical activity	Unadjusted prevalence of combination (% , SE)	Adjusted hazard ratio (95% confidence interval)*
Total				
-	-	-	12.6 (0.7)	1.00
+	-	-	25.0 (0.9)	0.53 (0.33, 0.85)
-	+	-	4.1 (0.2)	1.03 (0.57, 1.86)
-	-	+	5.7 (0.3)	0.97 (0.56, 1.67)
+	+	-	17.4 (0.4)	0.52 (0.35, 0.77)
+	-	+	17.0 (0.6)	0.33 (0.18, 0.61)
-	+	+	2.3 (0.2)	0.49 (0.25, 0.98)
+	+	+	15.9 (1.2)	0.17 (0.11, 0.27)

* Adjusted for age, gender, race or ethnicity, educational status, alcohol use, and energy intake.

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