Low-Risk Lifestyle Behaviors and All-Cause Mortality: Findings From the National Health and Nutrition Examination Survey III Mortality Study

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Objectives. We examined the relationship between 4 low-risk behaviors—never smoked, healthy diet, adequate physical activity, and moderate alcohol consumption—and mortality in a representative sample of people in the United States.

Methods. We used data from 16958 participants aged 17 years and older in the National Health and Nutrition Examination Survey III Mortality Study from 1988 to 2006.

Results. The number of low-risk behaviors was inversely related to the risk for mortality. Compared with participants who had no low-risk behaviors, those who had all 4 experienced reduced all-cause mortality (adjusted hazard ratio [AHR]=0.37; 95% confidence interval [CI]=0.28, 0.49), mortality from malignant neoplasms (AHR=0.34; 95% CI=0.20, 0.56), major cardiovascular disease (AHR=0.35; 95% CI=0.24, 0.50), and other causes (AHR=0.43; 95% CI=0.25, 0.74). The rate advancement periods, representing the equivalent risk from a certain number of years of chronological age, for participants who had all 4 high-risk behaviors compared with those who had none were 11.1 years for all-cause mortality, 14.4 years for malignant neoplasms, 9.9 years for major cardiovascular disease, and 10.6 years for other causes.

Conclusions. Low-risk lifestyle factors exert a powerful and beneficial effect on mortality. (*Am J Public Health.* 2011;101:1922–1929. doi:10.2105/AJPH.2011.300167)

Lifestyle behaviors lie at the root of many chronic diseases.[1–3] Smoking, unhealthy diets, and sedentary behavior predispose numerous people to diseases that rank among the leading causes of death such as heart disease, cancer, stroke, and diabetes. The costs associated with these behaviors are enormous.[4–7]

Previous studies have generally examined the independent effect of these lifestyle behaviors in isolation on a variety of adverse health outcomes. Yet, optimal health is only achieved by maximizing the number of healthy behaviors. Therefore, examining the joint effect of multiple lifestyle behaviors on health outcomes yields valuable insights into the improvements in health that are potentially achievable in populations. Starting around 2000, research appeared that examined the impact of multiple low-risk lifestyle behaviors on various health outcomes including cardiovascular disease,[8–15] diabetes,[16–18] all-cause mortality,[19–25] and mortality from cancer.[23–25]

Few studies relating multiple low-risk lifestyle factors to all-cause mortality have been conducted in the United States or have included substantial samples of racial/ethnic minorities.[22,24] Therefore, we examined the relationship between 4 lifestyle behaviors—never smoked, healthy diet, adequate physical activity, and moderate alcohol consumption—and all-cause mortality in a national sample of people in the United States.

METHODS

We used the public data files for the 2006 follow-up of the National Health and Nutrition Examination Survey (NHANES) III Mortality Study.[26] From 1988 through 1994, a representative sample of the noninstitutionalized civilian US population was selected through a multistage, stratified sampling design. Participants were interviewed at home and invited for a clinical examination. Persons aged 60 years or older, African Americans, and Mexican Americans were oversampled. Details about the original survey and its methods have been published previously.[27] The study received approval from the institutional review board at the National Center for Health Statistics.

Outcomes

The mortality status of participants aged 17 years or older in the original NHANES III was ascertained in 2006 with the National Death Index. Participants who were not deemed to have died as of December 31, 2006, were considered to be alive. Of the original 20050 participants, 5360 were determined to have died, 14664 were considered to be alive, and for 26 participants mortality status could not be determined. 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 disease (*International Classification of Diseases, 10th Revision*[28] *[ICD-10]* I00-I78), malignant neoplasms (*ICD-10* C00-C97), and all other causes of death.

The lifestyle behaviors of interest included never smoked, healthy diet, adequate physical activity, and moderate alcohol consumption. We created 2 levels of smoking status: high-risk (participants who currently smoked [had smoked 100 cigarettes during their life and were currently smoking] or [had quit smoking] [had smoked 100 cigarettes and were not currently smoking]), and low-risk (those who had never smoked [had never smoked 100 cigarettes]).

We considered participants in the top 40% of the Healthy Eating Index to show evidence of healthy eating (low-risk) and those in the

bottom 60% to show evidence of unhealthy eating (high-risk). The Healthy Eating Index is a score that ranges from 0 to 100 and has 10 subcomponents: grains, fruits, vegetables, dairy, meats, fats, saturated fat, cholesterol, sodium, and variety.[29] Scores for each of the 10 components ranged from 0 to 10. The index and its component scores were determined from dietary information collected by a single 24-hour recall administered in person to participants attending the medical examination.

Interviewers asked respondents whether they participated and, if so, their frequency of participation in 9 specific and up to 4 additional activities during the previous month. We considered participants who were moderately or vigorously active to show evidence of engaging in adequate physical activity (low-risk). All others were considered to be at high-risk. We defined vigorously active as participating 3 or more times per week in an activity with a metabolic equivalent level of 6 or more for participants who were aged 60 years or older and 7 or more metabolic equivalents for participants who were younger than 60 years. We defined moderately active as participating 5 or more times per week in activities of which no more than 2 could be considered vigorous activities.

Via a food-frequency questionnaire, interviewers asked participants how often they consumed beer, wine, or hard liquor during the past month. We considered men who reported consuming 60 or fewer drinks per month (corresponding to ≤2 drinks/day), but more than 0 drinks, and women who reported consuming 30 or fewer drinks per month (corresponding to ≤1 drinks/day), but more than 0 drinks, as moderate users of alcohol (low-risk). Because the form of the relationship between alcohol use and health outcomes is often nonlinear with an increase in risk estimates for abstainers of alcohol, we combined participants who reported no alcohol intake during the past month with participants who reported consuming alcohol in excess of moderate quantities (high-risk).

Data Analysis

Covariates included in the analyses were age, gender, race or ethnicity, educational status, and histories of myocardial infarction, stroke, congestive heart failure, cancer, and diabetes.

We tested differences in percentages with the χ^2 test. We used proportional hazard regression analysis to examine the independent association between individual and multiple health behaviors and mortality. We calculated rate advancement periods for the number of low-risk lifestyle behaviors.[30,31] Rate advancement periods provide an estimate of the number of years of chronological age that it would take to yield the equivalent risk for an outcome of interest associated with an exposure of interest. Population attributable fractions for the study endpoints were calculated by using the formula

$$(1)\quad 1-1/\sum_{i=0}^{k}(p_i\,RR_i),$$

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 ith level compared with the reference level.[32] The population attributable fraction provides an estimate of how much of an adverse event could be eliminated if the rate of an adverse event in the various exposure categories could be reduced to the rate in the reference category. To account for the complex survey design, we conducted analyses with the statistical software SUDAAN version 10.0 (Research Triangle Institute, Research Triangle Park, NC).

RESULTS

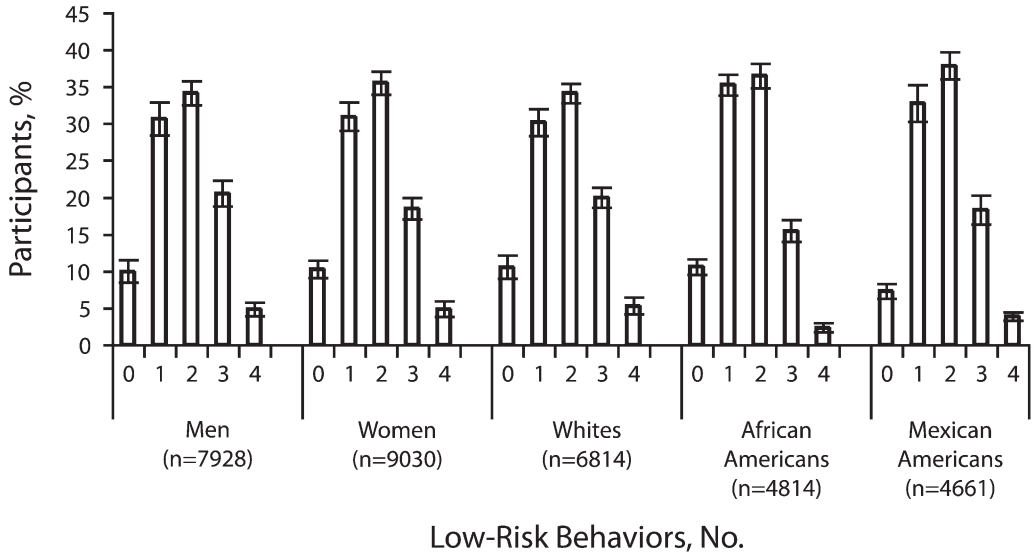
Of the 20 024 participants for whom mortality status was determined, 17 694 attended the mobile examination center. Information for the 4 behavioral variables was available for 17 069 participants. After we excluded missing data for covariates, 16 958 participants (3953 deaths: 863 from malignant neoplasm, 1730 from major cardiovascular disease, and 1360 from other causes) were included in the analyses. The analyses included 7928 men (2145 deaths), 6814 Whites (2165 deaths), 4814 African Americans (987 deaths), and 4661 Mexican Americans (715 deaths). The weighted demographic characteristics of the sample were younger than 45 years, 59.6%; 45 to 64 years old, 24.6%; 65 years old or older, 15.8%; men, 47.6%; Whites, 75.9%; African Americans, 11.1%; Mexican Americans, 5.2%; other race or ethnicity, 7.7%; and mean education, 12.3 years. Mean follow-up was 168 months. Compared with participants who were included in the analyses, those who were excluded were 2.8 years older (P=.050), had about 0.5 years less education (P=.129), were more likely to be men (51.8% vs 47.6%; P=.120), and were less likely to be White (67.8% vs 75.9%; P=.04).

At baseline, 10.1% of participants had no low-risk behaviors, 30.8% had 1, 34.9% had 2, 19.5% had 3, and 4.8% had 4. The distribution of the number of low-risk behaviors did not differ significantly by gender (P=.328) but did differ by race or ethnicity (P<.001; Figure 1). Of the 4 behaviors, 47.5% of participants had never smoked, 51.0% were moderate drinkers, 39.3% showed evidence of a healthy diet, and 40.2% showed evidence of adequate physical activity.

Low-Risk Behaviors and Mortality

All 4 low-risk behaviors were significantly associated with a reduction in all-cause mortality (Table 1). Of the 4 low-risk behaviors, never smoked had the smallest adjusted hazard ratio (AHR) of 0.64 (95% confidence interval [CI]=0.57, 0.71). However, there was some variation in the relative magnitude of hazard ratios of the low-risk behaviors for the different outcomes. Never smoked displayed the smallest hazard ratio for malignant neoplasms and other causes, and moderate alcohol use had the smallest hazard ratio for major cardiovascular disease. Adequate physical activity and moderate alcohol intake were not significant predictors of malignant neoplasms, and a healthy diet score was not significantly associated with major cardiovascular disease and other causes.

As the number of low-risk lifestyle behaviors increased, the risk of all-cause mortality and mortality from major cardiovascular disease and other causes decreased progressively (Table 1). Compared with participants with no low-risk lifestyle behaviors, participants with 4 such behaviors were 63% less likely to die, 66% less likely to die from a malignant neoplasm, 65% less likely to die from major cardiovascular disease, and 57% less likely to die from other causes. In a separate model to which we added histories of myocardial



Note. Bars represent a 95% confidence interval.

FIGURE 1—Distribution of low-risk lifestyle behaviors among participants aged 17 years or older at baseline: National Health and Nutrition Examination Survey III Mortality Study, United States, 1988–2006.

infarction, stroke, congestive heart failure, cancer, and diabetes (3889 deaths among 16 683 participants), the hazard ratios for all-cause mortality differed little from those in Table 1: 0.75 (95% CI=0.66, 0.86) for participants with 1 low-risk behavior, 0.63 (95% CI=0.55, 0.73) for participants with 2 behaviors, 0.48 (95% CI=0.41, 0.56) for participants with 3 behaviors, and 0.40 (95% CI=0.30, 0.53) for participants with 4 low-risk behaviors. Finally, we repeated the models after excluding various prevalent chronic conditions (Table 1). The exclusions resulted in minor changes in the hazard ratios.

Effect Modification

Gender differences were noted for the relationship between the number of low-risk behaviors and all-cause mortality (P=.021) but not malignant neoplasms (P=.98), major cardiovascular disease (P=.084), and other causes of deaths (P=.604). For men, the hazard ratios for all-cause mortality were 0.70 (95% CI=0.59, 0.82) for 1 low-risk behavior, 0.61 (95% CI=0.48, 0.76) for 2 behaviors, 0.52 (95% CI=0.41, 0.65) for 3 behaviors, and 0.38 (95% CI=0.27, 0.56) for 4 behaviors. For women, the hazard ratios were 0.78 (95% CI=0.62, 0.99), 0.62 (95% CI=0.50, 0.78), 0.38 (95% CI=0.29, 0.49), and 0.37 (95% CI=0.23, 0.58), respectively.

To examine potential effect modification by race or ethnicity, we combined the strata of participants with 3 and 4 low-risk behaviors. After adjustment for age, gender, and education, differences were present for other causes of death (P=.02) but not for all-cause mortality (P=.147), malignant neoplasms (P=.174), and major cardiovascular disease (P=.455). For Whites, the AHRs for other causes of death were 0.62 (95% CI=0.49, 0.80) for 1 low-risk behavior, 0.50 (95% CI=0.36, 0.70) for 2 behaviors, and 0.45 (95% CI=0.33, 0.63) for 3 or 4 behaviors. For African Americans, the AHRs were 1.00 (95% CI=0.73, 1.38) for 1 low-risk behavior, 1.04 (95% CI=0.76, 1.42) for 2 behaviors, and 0.66 (95% CI=0.38, 1.15) for 3 or 4 behaviors. For Mexican Americans, the AHRs were 0.94 (95% CI=0.65, 1.36) for 1 low-risk behavior, 0.83 (95% CI=0.61, 1.14) for 2 behaviors, and 0.88 (95% CI=0.57, 1.35) for 3 or 4 behaviors.

We also calculated the AHRs for the 16 mutually exclusive combinations of low-risk lifestyle factors (Table 2). Among all participants, the combination of never smoked, healthy diet, and moderate alcohol use yielded a hazard ratio of similar magnitude as the hazard ratio for participants who had all 4 low-risk lifestyle behaviors (AHR=0.37; 95% CI=0.25, 0.55).

Population Attributable Fractions and Rate Advancement Periods

To calculate the population attributable fractions, we estimated the AHRs associated with increasing numbers of high-risk behaviors—currently or formerly smoking, bottom 60% of the Healthy Eating Index, inadequate physical activity, and alcohol consumption other than moderate—by using the category of no high-risk behaviors as the referent. The population attributable fraction was 42% for mortality, 34% for malignant neoplasms, 55% for major cardiovascular disease, and 32% for other deaths. Rate advancement periods showed that, compared with participants with no high-risk behaviors, participants with 4 high-risk behaviors had an increase in risk that was equivalent to the risk from 11.1 years of chronological age for all-cause mortality, 14.4 years of chronological age for malignant neoplasms, 9.9 years of chronological age for major cardiovascular disease, and 10.6 years of chronological age for mortality from other causes (Table 3).

TABLE 1—Adjusted Hazard Ratios for Causes of Death Among Participants Aged 17 Years or Older: National Health and Nutrition Examination Survey III Mortality Study, United States, 1988–2006

Low-Risk Behaviors	All-Cause Mortality,[a] AHR (95% CI)	Malignant Neoplasms,[b] AHR (95% CI)	Major Cardiovascular Disease,[c] AHR (95% CI)	Other Causes,[d] AHR (95% CI)	All-Cause Mortality,[e] AHR (95% CI)	Malignant Neoplasms,[f] AHR (95% CI)	Major Cardiovascular Disease,[g] AHR (95% CI)
Individual behaviors[h]							
Never smoked	0.64 (0.57, 0.71)	0.40 (0.32, 0.51)	0.75 (0.65, 0.86)	0.69 (0.57, 0.83)	0.64 (0.55, 0.74)	0.40 (0.30, 0.54)	0.79 (0.68, 0.91)
Healthy diet	0.83 (0.75, 0.91)	0.59 (0.49, 0.71)	0.92 (0.79, 1.07)	0.92 (0.76, 1.11)	0.80 (0.71, 0.90)	0.61 (0.49, 0.76)	0.89 (0.74, 1.08)
Adequate physical activity	0.81 (0.74, 0.89)	0.89 (0.74, 1.07)	0.80 (0.71, 0.91)	0.76 (0.65, 0.89)	0.79 (0.70, 0.88)	0.93 (0.78, 1.12)	0.79 (0.68, 0.92)
Moderate alcohol use	0.79 (0.71, 0.88)	0.88 (0.72, 1.08)	0.70 (0.57, 0.85)	0.85 (0.74, 0.98)	0.86 (0.75, 0.99)	0.94 (0.74, 1.19)	0.73 (0.58, 0.92)
Individual behaviors[i]							
Never smoked	0.63 (0.56, 0.70)	0.41 (0.32, 0.52)	0.73 (0.63, 0.84)	0.68 (0.57, 0.82)	0.64 (0.55, 0.74)	0.41 (0.31, 0.55)	0.77 (0.66, 0.90)
Healthy diet	0.87 (0.79, 0.96)	0.63 (0.52, 0.77)	0.96 (0.83, 1.12)	0.97 (0.80, 1.17)	0.85 (0.75, 0.96)	0.65 (0.51, 0.83)	0.93 (0.78, 1.11)
Adequate physical activity	0.82 (0.75, 0.91)	0.93 (0.77, 1.13)	0.82 (0.72, 0.92)	0.77 (0.65, 0.90)	0.80 (0.71, 0.90)	0.97 (0.80, 1.18)	0.80 (0.69, 0.93)
Moderate alcohol use	0.78 (0.70, 0.86)	0.83 (0.69, 1.01)	0.69 (0.57, 0.84)	0.84 (0.73, 0.97)	0.85 (0.74, 0.97)	0.89 (0.71, 1.11)	0.73 (0.58, 0.92)
Low-risk behaviors,[h] no.							
0 (Ref)	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1	0.73 (0.63, 0.85)	0.60 (0.47, 0.76)	0.89 (0.72, 1.11)	0.68 (0.56, 0.82)	0.69 (0.56, 0.86)	0.66 (0.50, 0.87)	0.86 (0.63, 1.17)
2	0.61 (0.53, 0.71)	0.47 (0.37, 0.61)	0.75 (0.60, 0.93)	0.59 (0.45, 0.77)	0.56 (0.45, 0.69)	0.53 (0.40, 0.70)	0.72 (0.55, 0.95)
3	0.44 (0.38, 0.52)	0.23 (0.17, 0.31)	0.56 (0.43, 0.71)	0.50 (0.37, 0.68)	0.44 (0.35, 0.57)	0.26 (0.18, 0.36)	0.58 (0.41, 0.83)
4	0.37 (0.28, 0.49)	0.34 (0.20, 0.56)	0.35 (0.24, 0.50)	0.43 (0.25, 0.74)	0.39 (0.26, 0.58)	0.41 (0.23, 0.72)	0.33 (0.20, 0.53)

Note. AHR = adjusted hazard ratio; CI = confidence interval.
[a]3953 deaths among 16 958 participants.
[b]863 deaths among 16 958 participants.
[c]1730 deaths among 16 958 participants.
[d]1360 deaths among 16 958 participants.
[e]2295 deaths among 13 961 participants. Those who reported ever having been told by a doctor that they had myocardial infarction, stroke, congestive heart failure, cancer, or diabetes were excluded.
[f]725 deaths among 16 339 participants. Those who reported ever having been told by a doctor that they had cancer were excluded.
[g]1182 deaths among 15 416 participants. Those who reported ever having been told by a doctor that they had myocardial infarction, stroke, or congestive heart failure were excluded.
[h]Adjusted for age, gender, race or ethnicity, and educational status.
[i]Adjusted for age, gender, race or ethnicity, educational status, and other low-risk behaviors.

DISCUSSION

Using a sample of the US population, we showed that 4 low-risk behaviors exert a powerful protective effect on mortality and several cause-specific categories of mortality. Compared with participants who had no low-risk lifestyle behaviors, those who had all 4 such behaviors were 63% less likely to die, and, furthermore, the number of low-risk behaviors was related to mortality in a dose-related fashion. Although never smoked was the strongest protective factor for mortality, some variation in the predictive ability of the low-risk behaviors with respect to the category-specific causes of death was evident.

Our results are consistent with the results of several other studies that also related low-risk lifestyle factors to all-cause mortality.[20–25] In the Healthy Ageing: a Longitudinal Study in Europe, 1507 men and 832 women aged 70 to 90 years were followed on average for 10 years.[20] Four behaviors—healthy diet, alcohol intake of greater than 0 grams per day, not currently smoking, and adequate physical activity—were studied with respect to mortality. Compared with participants with 0 or 1 low-risk behaviors, those who had all 4 behaviors had reduced risks of all-cause mortality (AHR=0.35; 95% CI=0.28, 0.44), coronary heart disease (AHR=0.27; 95% CI=0.14, 0.53), cardiovascular disease (AHR=0.33; 95% CI=0.22, 0.47), cancer (AHR=0.31; 95% CI=0.19, 0.50), and other causes (AHR=0.33; 95% CI=0.19, 0.58). An Australian study that included 8 healthy behaviors (not currently smoking, adequate physical activity, moderate alcohol use, 4 dietary items, and body mass index [BMI; weight in kg divided by height in meters squared]<25 kg/m^2) showed that the lifestyle score created from these behaviors was inversely related to mortality among 7989 men aged 65 to 83 years followed for 5 years.[21]

In an analysis of data from the Atherosclerosis Risk in Communities Study, adoption of 4 healthy behaviors (≤5 fruits and vegetables/day; regular exercise; BMI 18.5 to 29.9 kg/m^2; and not currently smoking) was associated with a reduced risk for mortality (AHR=0.60; 95% CI=0.39, 0.62) over a 4-year period.[22] In the European Prospective Investigation into Cancer and Nutrition (EPIC)–Norfolk Study, 20 244 participants aged 45 to 79 years were followed for 11 years.[23] Compared with participants who did not currently smoke, were not physically inactive, consumed moderate amounts of alcohol, and had plasma vitamin C concentrations greater than 50 millimoles per liter, the number of low-risk lifestyle factors was inversely related to mortality, and those with none of those factors

TABLE 2—Adjusted Hazard Ratios for Causes of Death Among Participants Aged 17 Years and Older: National Health and Nutrition Examination Survey III Mortality Study, United States, 1988–2006

	Healthy Behaviors					Mortality			
	Never smoked	Healthy Diet	Adequate Physical Activity	Moderate Alcohol Use	Unadjusted % (SE)	All Causes, AHR[a](95% CI)	Malignant Neoplasms, AHR[a](95% CI)	Major Cardiovascular Disease, AHR[a](95% CI)	Other Causes, AHR[a](95% CI)
Men									
	–	–	–	–	9.9 (0.8)	1.00	1.00	1.00	1.00
	+	–	–	–	5.4 (0.6)	0.49 (0.34, 0.70)	0.32 (0.18, 0.59)	0.61 (0.38, 0.98)	0.47 (0.23, 0.94)
	–	+	–	–	4.2 (0.4)	0.81 (0.65, 1.00)	0.47 (0.25, 0.88)	1.01 (0.74, 1.38)	0.86 (0.55, 1.35)
	–	–	+	–	5.3 (0.6)	0.74 (0.55, 0.99)	0.89 (0.54, 1.46)	0.64 (0.43, 0.98)	0.71 (0.46, 1.11)
	–	–	–	+	15.7 (0.7)	0.69 (0.55, 0.86)	0.73 (0.48, 1.12)	0.72 (0.47, 1.12)	0.61 (0.44, 0.85)
	+	+	–	–	2.8 (0.3)	0.58 (0.45, 0.74)	0.21 (0.10, 0.45)	0.73 (0.47, 1.15)	0.72 (0.42, 1.22)
	+	–	+	–	4.9 (0.4)	0.47 (0.30, 0.75)	0.26 (0.15, 0.45)	0.57 (0.26, 1.24)	0.53 (0.29, 0.96)
	+	–	–	+	6.2 (0.4)	0.55 (0.34, 0.90)	0.34 (0.14, 0.81)	0.48 (0.20, 1.14)	0.79 (0.39, 1.61)
	–	+	+	–	3.8 (0.4)	0.62 (0.46, 0.83)	0.39 (0.20, 0.74)	0.80 (0.53, 1.21)	0.59 (0.39, 0.89)
	–	+	–	+	6.2 (0.5)	0.60 (0.43, 0.84)	0.62 (0.34, 1.13)	0.63 (0.41, 0.97)	0.54 (0.30, 1.00)
	–	–	+	+	10.2 (0.6)	0.71 (0.54, 0.91)	0.82 (0.45, 1.48)	0.68 (0.44, 1.07)	0.62 (0.41, 0.95)
	+	+	+	–	3.0 (0.4)	0.54 (0.38, 0.75)	0.23 (0.10, 0.54)	0.69 (0.46, 1.02)	0.63 (0.29, 1.35)
	+	+	–	+	4.2 (0.4)	0.43 (0.20, 0.95)	0.10 (0.04, 0.27)	0.45 (0.17, 1.20)	0.68 (0.24, 1.95)
	+	–	+	+	7.1 (0.6)	0.54 (0.37, 0.81)	0.31 (0.08, 1.18)	0.55 (0.31, 0.99)	0.71 (0.34, 1.49)
	–	+	+	+	6.2 (0.6)	0.53 (0.39, 0.72)	0.33 (0.15, 0.70)	0.59 (0.40, 0.89)	0.65 (0.38, 1.10)
	+	+	+	+	4.8 (0.4)	0.39 (0.27, 0.56)	0.39 (0.21, 0.73)	0.23 (0.12, 0.44)	0.56 (0.26, 1.20)
Women									
	–	–	–	–	10.2 (0.6)	1.00	1.00	1.00	1.00
	+	–	–	–	12.9 (0.6)	0.65 (0.49, 0.86)	0.41 (0.21, 0.78)	1.10 (0.76, 1.59)	0.46 (0.31, 0.68)
	–	+	–	–	4.7 (0.4)	0.92 (0.64, 1.32)	0.55 (0.33, 0.92)	1.14 (0.68, 1.93)	1.05 (0.64, 1.71)
	–	–	+	–	3.8 (0.4)	0.81 (0.57, 1.15)	0.85 (0.43, 1.66)	1.19 (0.73, 1.96)	0.50 (0.25, 0.97)
	–	–	–	+	9.5 (0.7)	0.95 (0.65, 1.37)	0.90 (0.52, 1.54)	1.21 (0.65, 2.25)	0.73 (0.37, 1.45)
	+	+	–	–	10.8 (0.6)	0.59 (0.46, 0.76)	0.27 (0.15, 0.49)	0.96 (0.64, 1.43)	0.52 (0.35, 0.79)
	+	–	+	–	5.3 (0.3)	0.48 (0.35, 0.65)	0.47 (0.24, 0.91)	0.59 (0.38, 0.92)	0.41 (0.23, 0.71)
	+	–	–	+	7.1 (0.5)	0.45 (0.26, 0.78)	0.43 (0.15, 1.19)	0.43 (0.18, 1.03)	0.43 (0.18, 1.00)
	–	+	+	–	3.7 (0.4)	0.91 (0.68, 1.22)	1.02 (0.62, 1.70)	1.31 (0.82, 2.08)	0.57 (0.30, 1.06)
	–	+	–	+	4.1 (0.5)	0.73 (0.48, 1.09)	0.68 (0.32, 1.43)	0.89 (0.53, 1.52)	0.64 (0.29, 1.42)
	–	–	+	+	4.6 (0.4)	0.67 (0.36, 1.25)	0.58 (0.22, 1.49)	0.77 (0.27, 2.17)	0.66 (0.25, 1.75)
	+	+	+	–	6.2 (0.5)	0.40 (0.29, 0.55)	0.26 (0.15, 0.46)	0.67 (0.38, 1.16)	0.29 (0.16, 0.55)
	+	+	–	+	5.1 (0.5)	0.34 (0.21, 0.55)	0.24 (0.09, 0.66)	0.40 (0.20, 0.80)	0.37 (0.16, 0.85)
	+	–	+	+	3.5 (0.3)	0.28 (0.17, 0.49)	0.02 (0.00, 0.11)	0.79 (0.40, 1.58)	0.17 (0.04, 0.65)
	–	+	+	+	3.7 (0.4)	0.43 (0.27, 0.68)	0.20 (0.07, 0.54)	0.46 (0.19, 1.09)	0.61 (0.28, 1.34)
	+	+	+	+	4.8 (0.5)	0.37 (0.24, 0.58)	0.31 (0.12, 0.82)	0.53 (0.31, 0.90)	0.30 (0.13, 0.69)
Total									
	–	–	–	–	10.1 (0.6)	1.00	1.00	1.00	1.00
	+	–	–	–	9.4 (0.4)	0.59 (0.49, 0.71)	0.35 (0.23, 0.53)	0.87 (0.67, 1.12)	0.50 (0.37, 0.67)
	–	+	–	–	4.5 (0.3)	0.86 (0.69, 1.06)	0.49 (0.34, 0.71)	1.04 (0.82, 1.33)	0.99 (0.69, 1.42)
	–	–	+	–	4.5 (0.4)	0.76 (0.60, 0.96)	0.90 (0.64, 1.26)	0.79 (0.57, 1.08)	0.61 (0.41, 0.92)
	–	–	–	+	12.4 (0.5)	0.77 (0.63, 0.94)	0.78 (0.56, 1.09)	0.86 (0.59, 1.26)	0.65 (0.48, 0.89)
	+	+	–	–	7.0 (0.4)	0.57 (0.49, 0.67)	0.23 (0.15, 0.34)	0.82 (0.64, 1.05)	0.62 (0.44, 0.87)
	+	–	+	–	5.1 (0.2)	0.47 (0.39, 0.59)	0.37 (0.21, 0.63)	0.55 (0.38, 0.81)	0.48 (0.31, 0.76)
	+	–	–	+	6.7 (0.4)	0.50 (0.35, 0.71)	0.39 (0.19, 0.79)	0.46 (0.25, 0.85)	0.62 (0.39, 0.98)
	–	+	+	–	3.8 (0.3)	0.75 (0.61, 0.91)	0.67 (0.49, 0.92)	0.97 (0.71, 1.32)	0.58 (0.40, 0.84)

Continued

TABLE 2—*Continued*

–	+	–	+	5.1 (0.3)	0.64 (0.50, 0.83)	0.65 (0.42, 0.99)	0.71 (0.50, 1.00)	0.57 (0.32, 0.99)
–	–	+	+	7.2 (0.4)	0.71 (0.55, 0.91)	0.73 (0.46, 1.16)	0.73 (0.47, 1.13)	0.64 (0.42, 1.00)
+	+	+	–	4.7 (0.4)	0.43 (0.35, 0.53)	0.23 (0.14, 0.35)	0.63 (0.45, 0.87)	0.40 (0.26, 0.61)
+	+	–	+	4.7 (0.3)	0.37 (0.25, 0.55)	0.18 (0.08, 0.39)	0.40 (0.23, 0.68)	0.51 (0.27, 0.96)
+	–	+	+	5.3 (0.4)	0.46 (0.33, 0.64)	0.19 (0.05, 0.65)	0.63 (0.41, 0.97)	0.53 (0.27, 1.05)
–	+	+	+	4.9 (0.4)	0.50 (0.39, 0.63)	0.29 (0.17, 0.52)	0.56 (0.39, 0.80)	0.62 (0.42, 0.92)
+	+	+	+	4.8 (0.4)	0.38 (0.29, 0.49)	0.34 (0.21, 0.57)	0.35 (0.24, 0.50)	0.43 (0.25, 0.74)

Note. AHR = adjusted hazard ratio; CI = confidence interval; SE = standard error. The sample size was n = 16 958. A + sign denotes the presence of the listed behavior while a – sign denotes its absence.
[a]Adjusted for age, gender, race or ethnicity, and educational status.

were 4.04 (95% CI=2.95, 5.54) times as likely to die.

An analysis of 77 782 participants aged 34 to 59 years of the Nurses' Health Study who were followed for 24 years showed that the risk of mortality from all causes, cardiovascular disease, and cancer was directly related to the number of unhealthy lifestyle factors (cigarette smoking, overweight status, inadequate physical activity, excessive alcohol intake, and poor diet).[24] Compared with participants who had no unhealthy lifestyle factors, those with 5 were 4.31 (95% CI=3.51, 5.31) times as likely to die, 8.17 (95% CI=4.96, 13.47) times as likely to die of cardiovascular disease, and 3.26 (95% CI=2.45, 4.34) times as likely to die of cancer. In a study of 4886 participants aged 18 years and older of the Health and Lifestyle Survey in the United Kingdom, the risk for all-cause mortality increased progressively as the number of unhealthy behaviors increased (AHR=3.49; 95% CI=2.31 5.26) for 4 versus 0 unhealthy behaviors.[25] Despite some variation in the choice and definition of lifestyle behaviors that exists among studies, the relative consistency in study results attests to the potent nature of healthy living.

In 2 previous studies, estimates of the rate advancement period for participants who had all unhealthy behaviors compared with those who had none were 14 years in the EPIC-Norfolk study and 12 years in the United Kingdom Health and Lifestyle Survey study.[23,25] Our estimate of 11 years is consistent with these previous calculations and offers insights into the quantity of life that can be potentially gained when people adopt healthy lifestyles.

Although many researchers have included moderate alcohol use as a low-risk lifestyle factor in their indices, any potentially favorable health impact from moderate alcohol use has to be carefully balanced against the well-documented harm caused by excessive alcohol use.[1–3,33] Even taking into account potential reductions in mortality from moderate alcohol consumption, the net impact from all alcohol use in many societies results in an increase in mortality and years of life lost.[34] Epidemiological evidence yields mixed conclusions regarding the effect of moderate alcohol use on different health outcomes. For example, moderate alcohol use has been reported to be associated with reduced all-cause mortality,[35,36] cardiovascular disease,[37,38] and diabetes.[39,40] However, the validity of observational studies has been questioned because of possible incomplete control of confounding and issues surrounding the proper specification of a referent group.[41,42] On the other hand, alcohol use does not appear to afford protection against many cancers,[38] including breast[43–45] and colorectal cancers.[46] Furthermore, the impact of alcohol use on intentional and unintentional injuries is clearly evident.[38,47]

To be consistent with the many studies that included moderate alcohol use in their indices of low-risk lifestyle factors, we also included moderate alcohol use in our study. Because of the existing uncertainty regarding the implications of moderate alcohol use, however, we also repeated the analysis after eliminating moderate alcohol use from our index of low-risk lifestyle factors. Compared with participants who reported no low-risk behavior, those reporting 1, 2, and 3 such behaviors were 25%, 40%, and 55% less likely to die during the follow-up period (AHR=0.75 [95% CI=0.67, 0.85]; AHR=0.60 [95% CI=0.54, 0.67]; and AHR=0.45 [95% CI=0.37, 0.55], respectively). Furthermore, the rate advancement periods were 3.1, 5.6, and 8.8 years for participants with 1, 2, and 3 low-risk behaviors, respectively. Although these reductions in mortality are slightly less than are those for the number of low-risk lifestyle factors that included moderate alcohol use, they are nevertheless impressive.

TABLE 3—Rate Advancement Periods and High-Risk Lifestyle Behaviors Among Participants Aged 17 Years or Older: National Health and Nutrition Examination Survey III Mortality Study, United States, 1988–2006

High-Risk Lifestyle Behaviors, No.	All-Cause Mortality	Malignant Neoplasms	Major Cardiovascular Disease	Other Causes of Death
0	Ref	Ref	Ref	Ref
1	1.9	–4.9	4.4	2.0
2	5.6	4.5	7.2	4.0
3	7.6	7.6	8.8	5.7
4	11.1	14.4	9.9	10.6

Note. High-risk behaviors were currently or formerly smoking, bottom 60% of the Healthy Eating Index, inadequate physical activity, and alcohol consumption other than moderate.

Limitations

The results from this study should be considered bearing in mind several limitations. The exposures of interest were based on self-reported data, and, therefore, some misclassification likely occurred. To the extent that misclassification was random, the results of this study were likely biased toward the null. If misclassification was not random because participants overreported healthy behaviors, the reduction in risk may have been underestimated. Furthermore, duration of physical activity was not assessed in NHANES III, and, therefore, we based our variable on frequency of participation of physical activity. It is unclear how the absence of duration data may have affected our results. The derivation of the Healthy Eating Index was based on a single 24-hour recall, which may have contributed to misclassification of participants. Furthermore, other dietary indexes exist, which may have yielded different findings. As was done in most previous studies, we dichotomized the lifestyle behaviors. Because participants who were former smokers or former users of alcohol may have elevated rates of adverse outcomes, the decision to include these groups or exclude them from the referent categories could affect a study's results. Finally, participants who were classified as moderate alcohol users in this study may have included binge drinkers who are known to suffer increased morbidity and mortality.

Conclusions

The challenges in convincing a larger proportion of people in the United States to adopt a healthy lifestyle are daunting. Previous analyses of representative samples of adults in the United States have demonstrated that only small percentages of adults meet all healthy lifestyle behaviors or factors.[48,49] Nevertheless, the nation has booked substantial progress in reducing the rate of smoking,[50] and some data indicate that physical activity may be increasing.[51] Because of the complexity of diet, it remains unclear how the nation fares. For example, energy intake has increased,[52] but the intake of fruits and vegetables has remained stable.[53] The mean alcohol volume declined in the United States, primarily during the 1980s.[54] Pushing the nation's people to adopt increasingly healthy behaviors will take the efforts of both the clinical and public health communities. National and professional guidelines for all 4 behaviors are available. The Surgeon General's reports on smoking have constituted the bedrock for the public health campaigns against smoking. New physical activity guidelines in 2008 provided the nation with a roadmap to improve physical activity levels.[55] National dietary guidelines are updated periodically.[56] For adults who elect to consume alcohol, the Dietary Guidelines for Americans recommend limiting the intake of alcohol to 2 or fewer drinks per day for men and to 1 or fewer drinks per day for nonpregnant women.[56]

Having never smoked, healthy diet, adequate physical activity, and moderate alcohol consumption were each significantly associated with a reduced risk of mortality, and the number of these behaviors was inversely associated with the risk for mortality. Our results add to the evidence base regarding the favorable effect of healthy living on mortality and reinforce objectives articulated in *Healthy People 2010*[57] as well as goals for 2020 developed by the American Heart Association.[58] The estimates of mortality that can be postponed underscore the need for improving the overall level of healthy living in the United States. ■

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Contributors

E.S. Ford originated the study, performed the analyses, and wrote the article. G. Zhao, J. Tsai, and C. Li assisted with the study and analysis.

Human Participant Protection

The institutional review board at the Centers for Disease Control and Prevention granted approval of National Health and Nutrition Examination Survey III, and participants provided documented consent.

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