Factors Associated with Healthy Aging: The Cardiovascular Health Study

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OBJECTIVES: To identify factors associated with remaining healthy in older adults.

DESIGN: Longitudinal cohort study.

SETTING: Data were collected at the four Cardiovascular Health Study field centers.

PARTICIPANTS: 5,888 participants age 65 years and older in the Cardiovascular Health Study.

MEASUREMENTS: Presence of chronic disease was assessed at baseline and over a maximum 7-year follow-up period. Participants who were free of chronic disease (no cardiovascular disease (CVD), chronic obstructive pulmonary disease, or self-reported cancer, except nonmelanoma skin cancer) at the baseline examination were then monitored for the onset of incident cancer, cardiovascular disease, and fatal outcomes.

RESULTS: A high proportion of these older adults was healthy at the initial examination and remained healthy over the follow-up period. Numerous behavioral factors were associated with continued health, including physical activity, refraining from cigarette smoking, wine consumption (women), higher educational status, and lower waist circumference. A number of CVD risk factors and subclinical disease measures were associated with continued health, including higher high-density lipoprotein (HDL) cholesterol, lack of diabetes, thinner common carotid intimal medial thickness, lower blood pressure, lower C-reactive protein, and higher ankle-arm blood pressure ratio. Among the behavioral factors, exercise, not smoking, and not taking aspirin remained significant predictors of health even after controlling for CVD risk factors and subclinical disease in older adults.

CONCLUSIONS: These data suggest that a number of modifiable behavioral factors (physical activity, smoking, and obesity) and cardiovascular risk factors (diabetes, HDL cholesterol, and blood pressure) are associated with maintenance of good health in older adults. **J Am Geriatr Soc 49: 254–262, 2001.**

Key words: epidemiology; cardiovascular disease; cancer; health; risk factors; disease prevention; aging

Risk factors associated with the development of coronary heart disease (CHD), stroke, other cardiovascular diseases (CVD), and cancer endpoints have been identified in middle-aged population groups.[1–3] More-recent studies have identified factors associated with chronic-disease risk in older adults.[4–6] While many risk factors for chronic disease are shared between middle-aged and older-aged groups, there may be differences in both the number and strength of predictors that alter the importance of traditional risk factors in predicting the incidence of disease and the preservation of health.

To develop more-effective chronic-disease-prevention strategies in older adults, it is important to identify factors associated with the major causes of morbidity and mortality in older people. Unfortunately most previous studies restricted the assessment of risk and protective factors to individual disease-specific outcomes. Thus, while substantial information is available pertaining to predictors of specific adverse events in middle-aged and older adults, much less information is available describing factors associated with remaining healthy.

A large proportion of Cardiovascular Health Study (CHS) participants were healthy and independently functioning at the onset of this observational study. In this manuscript we sought to identify factors associated with

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remaining free of chronic disease in later life by utilizing observations from this major cohort study of older adults. These analyses provide a unique opportunity to identify predictors of healthy living in an older cohort that may have implications for the development of prevention/public health strategies specifically tailored for older adults.

METHODS

Population

The CHS cohort consists of 5,888 men and women, age 65 years and older drawn from four U.S. communities—Forsyth County, North Carolina; Sacramento County, California; Washington County, Maryland; and Allegheny County, Pennsylvania. The cohort was identified using Medicare eligibility lists of the Health Care Finance Administration (HCFA) from these four communities. Eligible participants were 65 years of age and older at the time of examination, were community dwelling, and did not require a proxy respondent at baseline, as described previously.[7] Five thousand, two hundred and one men and women participated in a baseline examination in 1989–1990; an additional 687 African-American participants were recruited in 1992–1993.

Baseline Examination

The baseline examination consisted of a home interview and a clinic examination. Specific details of the examination have been described elsewhere.[8] Briefly, participants were asked to fast for 12 hours and fasting morning blood was collected for a complete blood count, serum chemistry, serum insulin, plasma lipids, and coagulation factors.[9]

Blood pressure (BP) was measured using a standard mercury sphygmomanometer (W. A. Baum Company, Inc., Copiague, NY) and repeated after three minutes of standing to assess postural changes. Duplicate measures of supine BP in the right arm and both ankles were performed using a standard mercury sphygmomanometer and an 8-MHz Doppler probe. The ratio of these measures (ankle-arm systolic BP ratio) was used as a measure of arterial occlusive disease in the lower extremities.

Functional status was assessed using an interviewer-administered questionnaire assessing self-reported difficulty in tasks of daily living including activities of daily living (ADL) and instrumental activities of daily living (IADL) scales, mobility, and upper extremity function.[10] Usual dietary intake was assessed using a modified Block food-frequency questionnaire administered via picture cards of foods sorted by frequency of use.[11] Anthropometric measurements included weight, height, waist circumference, and hip circumference.[8] Participants were asked about type and frequency of exercise, and two exercise measures were calculated: kilocalories expended per week and intensity of exercise.

Duplex ultrasonography of the carotid arteries was performed using a Toshiba SSA-270A ultrasound machine (Toshiba Medical Systems, Tustin, CA), as has been described.[12]

Classification of Morbidity

Participants were asked about their past medical history, and reported cardiovascular events were confirmed by a medical record review or by contacting the participant's

Table 1. Number and Rate of Incident Events in Participants Healthy at the Baseline Examination

		Women							
		Cancer		COPD		CVD*		Any Event†	
Age	N	n	Rate‡	n	Rate‡	n	Rate‡	n	Rate‡
65–69	825	65	13.5	19	3.8	109	23.2	186	41.0
70–74	638	56	15.3	15	4.0	113	32.2	173	51.2
75–79	370	30	14.6	16	7.6	90	46.6	126	67.6
80–84	148	11	13.8	4	4.9	41	56.2	62	89.2
85+	62	3	10.0	1	3.3	23	88.1	37	144.8
Total	2,043	165	14.2	55	4.6	376	33.8	584	54.5
		Men							
		Cancer		COPD		CVD*		Any Event†	
Age	N	n	Rate‡	n	Rate‡	n	Rate‡	n	Rate‡
65–69	440	54	21.8	11	4.3	85	35.7	139	61.0
70–74	438	54	22.4	17	6.8	119	53.4	172	81.3
75–79	238	39	31.2	5	3.8	77	68.4	117	109.1
80–84	130	19	29.8	10	15.3	49	84.8	75	137.2
85+	53	5	21.7	3	13.1	16	73.0	34	155.8
All	1,299	171	24.4	46	6.3	346	53.0	537	86.2

*CVD defined as angina, myocardial infarction, bypass surgery, angioplasty, stroke, transient ischemic attack, claudication, or congestive heart failure.
†Any event includes other events in table plus death.
‡Rate per thousand person-years. Multiple events per individual are possible.
N = total in group; n = number of events; COPD = chronic obstructive pulmonary disease; CVD = cardiovascular disease.

physician. All self-reports of CVD, defined as myocardial infarction, angina, congestive heart failure, stroke, transient ischemic attacks, and peripheral arterial disease, were verified from objective information obtained from hospital and physician records as has been described.[13] History of cancer at baseline was obtained by participant self-report. Chronic obstructive pulmonary disease (COPD) was defined as chronic bronchitis, asthma, or emphysema and was determined at baseline by participant self-report or a physician's diagnosis. Hypertension was defined as borderline (BP ≥140/90) or definite (BP ≥160/95 or current use of antihypertensive medication). Diabetes mellitus was defined according to the American Diabetes Association definition: impaired fasting glucose (IFG) if fasting glucose was 110–125 mg/dl, and diabetic if fasting glucose was ≥126 mg/dl or participant was taking insulin or oral hypoglycemic agents.

Participants were contacted every 6 months to determine whether they had any chronic disease event or hospitalizations. Information about all possible CVD events and all hospitalizations was collected from hospital records, physician questionnaires, or informant interviews. Information from these events was adjudicated by a physician review panel as has been previously described.[14,15] Cancer and COPD cases were identified using ICD-9 codes from the hospital record.

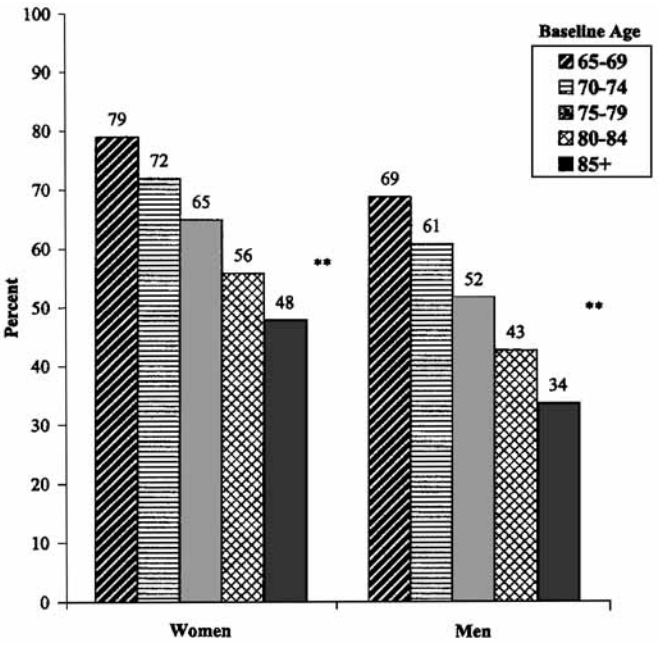
Data Analyses

These analyses focus on individuals who were healthy at the CHS baseline examination. Health was defined as no evidence of prevalent CVD, COPD, or cancer. Factors associated with health cross-sectionally are not presented in this manuscript, given the difficulties in determining the temporality of the findings (i.e., Did the factor precede or follow the onset of disease?). For the remaining analyses, prediction of continued health was restricted to participants who were disease free at baseline (n = 3,342). The outcomes of interest included any of the following incident events: cancer, COPD, angina, coronary angioplasty, coronary artery bypass surgery, claudication, congestive heart failure, acute myocardial infarction, stroke, transient ischemic attack, or any fatal event. Events through June 30, 1996 were considered, averaging 6.5 years of follow-up in the original cohort and 3.5 years in the African-American cohort (recruited, on average, 3 years after the original cohort).

Factors predicting remaining healthy during follow-up were assessed. A number of hypothesized behavioral factors, traditional risk factors, and measures of subclinical disease were considered. The behavioral factors considered were reported physical activity; alcohol consumption; smoking status; social support; self-reported health, including activities of daily living; influenza vaccination status; regular aspirin use (three or more times in the previous 2 weeks); demographic factors (age, ethnicity, education, income); and hormone replacement therapy (HRT) in women.

The traditional risk factors considered were body size and obesity, BP/hypertension, lipid/lipoprotein levels, coagulation factors, diabetes, and family history of myocardial infarction or stroke.

Subclinical measures of CVD considered included carotid artery wall thickness (the average of the standardized values for the common and internal carotid wall thicknesses) and ankle-arm BP index.



* participants remaining free of CVD, Cancer, COPD or Death over 6.5 years (original cohort) or 3.5 years (African American/new cohort), adjusted for cohort
** Significant differences across age groups (p<0.001)

Figure 1. Percentage of healthy participants that remained healthy during follow-up. CVD = cardiovascular disease; COPD = chronic obstructive pulmonary disease.

Given the interest in identifying beneficial health habits, the relationship between behavioral factors and health was assessed both before and after controlling for traditional risk factors and subclinical measures of disease. Age- and cohort-adjusted (original cohort, supplemental African-American cohort) bivariate associations were calculated to identify behavioral and other factors that predict remaining healthy in each cohort. To account for the different follow-up times in the two cohorts, survival analysis models were generated using time to first event as the dependent variable. We used an accelerated failure time model in which explanatory variables measured on an individual are assumed to affect the rate at which an individual progresses toward disease.[16] This model was chosen because the reciprocal of the acceleration factor may be interpreted as the proportion of years an individual with a given risk factor remains healthy compared with someone without the risk factor, when other explanatory variables in the model are held constant. The baseline hazard function was modeled with a Weibull distribution, and parameters were determined using SAS statistical software.[17] Stepwise models were run in two stages, first to determine the most significant behavioral factors and then to identify the most significant predictors among the traditional risk factors and measures of subclinical disease.

RESULTS

A large proportion of participants in all age groups, both men and women, were free of CVD, cancer, and COPD at the baseline examination. The highest percentage of healthy

Table 2. Percent Remaining Healthy During Follow-Up Period by Baseline Behavioral Factors

	Women		Men	
	N	% Healthy*	N	% Healthy*
Exercise intensity				
Non-exerciser	173	65‡	73	52§
Low	1,018	70	584	57
Moderate	654	75	496	61
High	197	79	144	66
Smoking				
Never	1,221	77‡	445	67‡
Former	574	68	700	57
Current	246	58	152	46
Alcohol use				
Any alcohol				
Yes	911	74	765	60
No	1,124	71	528	58
Drink wine				
Yes	939	75‖	664	61
No	1,097	70	627	57
Education (HS graduate)				
Yes	1,477	73	918	62§
No	559	69	375	53
Income (greater than $25,000)				
Yes	673	76§	578	64§
No	1,211	70	660	55
Financial change (last 6 months)				
Yes	201	63§	107	51
No	1,833	73	1,189	60
Influenza vaccination in last year				
Yes	802	73	512	59
No	1,212	71	778	59
Regular aspirin use (≥3 days/14)				
Yes	594	69‖	394	56
No	1,421	74	886	61
Self-reported health				
Excellent	338	81‡	244	72‡
Very good	580	76	374	64
Good	743	70	481	55
Fair	343	64	175	46
Poor	33	57	21	37
Hormone replacement therapy use				
Never	1,266	72		
Former	512	72		
Current	265	72		

Diet†	CVD, COPD, Cancer, or Death N = 1,120	Healthy N = 481	CVD, COPD, Cancer, or Death N = 1,120	CVD, COPD, Cancer, or Death N = 1,120	Healthy N = 566
% Kcal from fat	33.9	32.9‖	35.6		34.7
% Kcal from carbohydrates	47.9	49.1§	45.0		45.4

*Age- and cohort-adjusted percents.
†Available on only a subset of original cohort participants.
‡$P < .001$.
§$.001 < P < .01$.
‖$.01 < P < .05$.
N = number in group; CVD = cardiovascular disease; COPD = chronic obstructive pulmonary disease; HS = high school; Kcal = kilocalories.

Table 3. Level of Baseline Cardiovascular Disease Risk Factors by Health Status During Follow-Up Period

Variable*	Women		Men	
	CVD, COPD, Cancer, or Death N = 584	Healthy N = 1459	CVD, COPD, Cancer, or Death N = 537	Healthy N = 762
Blood pressure				
SBP (mmHg)	138.3	135.8†	139.6	133.9‡
DBP (mmHg)	70.3	69.9	74.3	72.4§
Lipids/lipoproteins				
Total cholesterol (mg/dl)	223.7	220.3	198.7	197.4
HDL cholesterol (mg/dl)	57.4	60.4‡	47.4	49.3§
LDL cholesterol (mg/dl)	138.5	133.5§	124.0	122.6
Waist circumference (cm)	93.45	91.26§	98.45	97.04†
C-reactive protein (mg/L)	2.26	1.81‡	2.00	1.54‡
Hemostatic factors				
Fibrinogen	326.6	322.9	319.9	310.9†
Factor VII	132.8	131.1	113.1	111.5
Factor VIII	126.3	122.4†	119.6	114.4†
Subclinical disease markers				
Ankle arm index	1.04	1.07‡	1.07	1.14‡
Common carotid IMT (mm)	1.05	1.00‡	1.13	1.06‡
Internal carotid IMT (mm)	1.38	1.26‡	1.60	1.40‡

Disease Measures		% Healthy		% Healthy
Diabetes				
Normal	N = 1,517	75‡	N = 883	64‡
Impaired fasting glucose	N = 264	67	N = 195	54
Diabetes	N = 244	58	N = 212	44
Hypertensive				
No	N = 852	77‡	N = 602	65‡
Borderline	N = 328	72	N = 205	59
Definite	N = 859	68	N = 492	52

*Means or percents adjusted for age and cohort.
†$.01 < P < .05$.
‡$P < .001$.
§$.001 < P < .01$.
N = number in group; CVD = cardiovascular disease; COPD = chronic obstructive pulmonary disease; SBP = systolic blood pressure; DBP = diastolic blood pressure; HDL = high-density lipoprotein; LDL = low-density lipoprotein; IMT = intimal medial thickness.

participants was observed in the youngest age group (65–69 years) for both women (66%) and men (57%), while the lowest rates were observed in the oldest age group (85 years and older) for both women (56%) and men (46%).

The number and incidence rates of specific outcomes are given in Table 1. The risk of incident events increased with age and the event rates were higher in men than in women. Over the average follow-up period of 6.5 years, a majority of healthy participants remained free of CVD, COPD, and cancer and remained alive (Figure 1). In women, the number of participants remaining healthy differed significantly across initial ages and ranged from 79% of those initially age 65–69 years to 48% of those initially 85 years and older. Similarly the percentage of male participants healthy at follow-up decreased significantly with age, from 69% at ages 65–69 years to 34% at ages 85 years and older.

A number of behavioral factors were associated with continued health in these older adults. Table 2 presents the age- and cohort-adjusted bivariate relationships between behavioral factors and remaining healthy in those participants free of cancer, CVD, and COPD at baseline. Exercise was positively related to continued health, with the strongest relationship observed in participants reporting a high level of exercise intensity. Never having smoked cigarettes or having previously quit smoking was associated with a higher likelihood of remaining healthy in both men and women. Higher educational status (men only) and higher income were positively associated with future health, while having a recent change in personal financial status was negatively associated with continued health. Self-reported health was a strong predictor of future health; participants initially reporting excellent or very good health had a 24% to 35% higher rate of remaining healthy when compared with participants reporting poor health. Use of HRT in women was not associated with remaining healthy during follow-up. Regular use of aspirin, which has been reported in CHS as a risk factor for stroke,[18] was associated with a decreased risk of remaining healthy. Dietary factors were associated with remaining healthy, with a significantly lower percentage of calories from fat and a higher

Table 4. Proportion of Healthy Years During Follow-Up Associated with Behavioral Factors

Variable	Proportion of Healthy Years Associated with Variable	95% Confidence Interval
Age (5 years)	0.79*	(0.75, 0.82)
Male gender	0.74*	(0.66, 0.83)
Waist (10 cm)	0.94†	(0.90, 0.98)
Exercise intensity		(1.07, 1.56)
No exercise	1.00*	(1.13, 1.67)
Low	1.30*	(1.18, 1.98)
Medium	1.37*	
High	1.53*	
Cigarette smoking		(0.66, 0.84)
Never	1.00*	(0.48, 0.66)
Former	0.75*	
Current	0.56*	
Wine drinking	1.11	(0.99, 1.24)
Regular aspirin use	0.82*	(0.73, 0.91)
Income (>$25,000)	1.19†	(1.06, 1.33)
Recent change in finances	0.78†	(0.66, 0.93)

Note: Effect size estimated with all behavioral factors included in the model. Analytic units are displayed for continuous variables.
*$P < .001$.
†$P < .01$

percentage of calories from carbohydrates (women only) consumed by participants who remained healthy. Wine drinking was associated with remaining healthy. It should be noted that wine drinking lacked variability in this population. Only 48% (1,268) of participants healthy at baseline reported drinking any wine, and of those 81% (1,032) averaged one or fewer drinks per week. Only 3% (43) of the wine drinkers averaged seven or more 6-ounce glasses of wine a week. Because wine drinking was so moderate, we were unable to detect any dose-response relationship, so it was modeled in the multivariate models as an indicator variable for any wine drinking. There was no association between remaining healthy and a more-broadly defined alcohol-consumption variable that included beer, wine, and liquor.

CVD risk factors and subclinical markers of disease were also related to continued health in these older adults (Table 3). Lower systolic BP and the absence of a history of hypertension were significantly related to remaining healthy in both men and women. Lower waist circumference was associated with remaining healthy but, after including waist circumference in multivariate models, total weight and body mass index were not. Lower C-reactive protein (a nonspecific inflammatory marker) and higher baseline HDL cholesterol levels were significantly associated with remaining healthy for both men and women, while lower low-density lipoprotein cholesterol levels were associated in women only. Hemostatic factors were significant predictors of remaining healthy (lower fibrinogen in men only and Factor VIII activity in both men and women). Less subclinical CVD (higher ankle-arm BP index and thinner carotid artery intimal medial thickness (IMT)) predicted continued good health in these older adults. The absence of diabetes was significantly related to remaining disease free.

Stepwise models were used to determine the most important factors that predict future health given the potential for interrelationships between health behaviors, risk factors, and subclinical disease. Table 4 shows the association of the behavioral factors with remaining healthy. Data are presented as the proportion of years of follow-up a person with a particular factor remained healthy compared with someone without the risk factor, adjusted for the other behavioral variables presented in the table. For example, a person who is a current cigarette smoker has a multiplication factor of 0.56, indicating that the person remained healthy only about half as long as a person who never smoked. Younger age, female gender, increased exercise intensity, lower waist circumference, not smoking cigarettes, and not using aspirin regularly were significantly related to continued health. Persons reporting baseline wine consumption ($P < .056$), higher income, and no recent change in finances were also more likely to remain healthy.

Table 5 presents the proportion of healthy years attributable to behavioral factors, risk factors, and subclinical disease measures. Given the interrelationships between these variables, all of them were included in this model to determine associations after adjustment for the other factors. Younger age, female gender, increased exercise intensity, refraining from cigarette smoking, no regular aspirin use, and not having a change in financial status remained significant predictors of health. Absence of CVD risk factors continued to be associated with remaining healthy, including higher HDL cholesterol levels, lower C-reactive protein levels, normal BP, and not having diabetes. The absence of subclinical markers of vascular disease (using higher ankle/arm BP index and thinner carotid artery IMT as markers) was also related to remaining healthy.

DISCUSSION

These data document that the majority of this community-based cohort of older adults was free of cancer, COPD, and CVD at the initial examination and remained healthy over a 6.5-year follow-up period. This indicates that even in an older cohort the maintenance of health is the norm rather than the exception among those who are initially healthy. While health is multidimensional, the ability of older adults to remain free of major chronic disease outcomes is an integral part of "successful aging."[19]

Identifying healthy behaviors that are associated with maintenance of health in older adults is important for efforts to enhance prevention of chronic disease. A number of modifiable behavioral factors, including exercising (especially with a higher level of intensity), refraining from cigarette smoking, moderate wine consumption, remaining nonobese, and consuming a healthy diet, were associated with continued health in older adults. While those who had never smoked were most likely to remain healthy, ex-smokers were more likely to remain healthy than current smokers. Other less-modifiable behaviors included higher income and not having a recent change in finances. Other studies have observed the relationship between behavioral factors and health. Survival to age 75 in the Framingham Study was greater in participants who smoked fewer cigarettes,[20] while refraining from smoking and remaining free of obesity were associated with remaining healthy in older

Table 5. Behavioral Factors, Risk Factors, and Subclinical Disease Measures Associated with Remaining Healthy During Follow-Up

Behavioral Factors	Proportion of Healthy Years Associated with Variable	(95% Confidence Interval)
Age (5 years)	0.82§	(0.78, 0.86)
Male gender	0.82§	(0.72, 0.92)
Waist (10 cm)	1.01	(0.96, 1.06)
Exercise intensity		
No exercise	1.00‖	
Low	1.25‖	(1.03, 1.52)
Medium	1.34‖	(1.09, 1.64)
High	1.42‖	(1.09, 1.85)
Cigarette smoking		
Never	1.00§	
Former	0.78§	(0.69, 0.88)
Current	0.66§	(0.56, 0.78)
Wine drinking	1.04	(0.93, 1.17)
Regular aspirin use	0.83‖	(0.75, 0.93)
Income (>$25,000)	1.08	(0.96, 1.22)
Recent change in finances	0.75‖	(0.63, 0.90)
Risk Factors/Subclinical Disease Factors		
Diabetes status		
Impaired fasting glucose	0.94§	(0.80, 1.10)
Diabetes	0.71§	(0.62, 0.82)
Ankle/arm BP ratio <0.9	0.73§	(0.62, 0.86)
Diastolic BP (1 standard deviation)*	0.92‖	(0.87, 0.97)
HDL (1 standard deviation)†	1.07¶	(1.01, 1.14)
Standardized carotid wall thickness (1 standard deviation)‡	0.85§	(0.81, 0.90)
Ln (CRP) mg/L	0.93‖	(0.88, 0.98)

Note: All behavioral, risk, and subclinical disease factors were included in the model. Analytic units are displayed for continuous variables.
*1 standard deviation = 11.4 mmHg.
†1 standard deviation = 15.5 mg/dl.
‡1 standard deviation = 0.83 mm.
‖$P = .01$.
§$P = .001$.
¶$P = .05$.
BP = blood pressure; HDL = high-density lipoprotein; CRP = C-reactive protein; Ln = natural logarithm.

Asian men.[21] We have previously reported that increased physical activity was associated with less subclinical CVD in CHS participants.[22]

In addition to behavioral factors, a number of CVD risk factors and subclinical disease measures were associated with continued health. The absence of hypertension, the presence of higher levels of HDL cholesterol, and the absence of diabetes likely are associated with continued health through their associations with reduced CVD risk. Lower C-reactive protein levels may be associated with a lower burden of CVD outcomes.[23] Of interest, both exercise and HDL cholesterol levels were significant predictors of health despite the fact that these variables are highly related to one another. Two subclinical disease markers, carotid wall thickness and ankle-arm BP index, were associated with remaining healthy. Studies in other populations have observed similar relationships between risk factors and health. HDL cholesterol has been shown to be higher in healthy older adults (85–89 years),[24] while BP was lower in healthy older adults in the Framingham and Honolulu cohort studies.[20,21] These results corroborate existing recommendations that proper health appraisals with subsequent treatment focused on hypertension, dyslipidemia, and diabetes may enhance the health of older adults.

While the relationship between a number of behavioral factors (obesity, physical activity, cigarette smoking) and health remained significant even after controlling for CVD risk factors and subclinical disease, it is crucial to note that the associations of other behavioral factors with health (e.g., wine consumption, obesity) may still be important. Since these behavioral factors may be associated with other known risk factors and subclinical disease markers, it seems prudent to consider the importance of a larger number of behavioral factors rather than focusing only on the health behaviors that remained significant after adjustment for risk factors and subclinical disease.

These analyses provide insights into factors associated with healthy older adults remaining free of cancer, CVD, and fatal outcomes. While these represent highly important health outcomes in older life, other factors are also important in the context of successful aging (e.g., physical, cognitive, and social function). It is possible that the be-

haviors associated with remaining free of chronic disease in older adults may be a result of lifelong health behaviors and, hence, even greater effects on outcomes may be possible with long-term or lifelong modification of these behaviors. Thus, these factors identified with remaining disease free should be an integral part of an overall preventive gerontologic program as has been previously suggested by Hazzard and others.[26]

As with any study, there are limitations of the design and analytic strategy of this study. The results may have been modified if some individuals' ability or willingness to adopt some of the behavioral factors was altered due to the presence of early disease. For example, it could be hypothesized that the group of older adults reporting regular physical activity represent the subset of individuals that were healthy enough to engage in this activity. The exclusion from these analyses of participants with known prevalent disease would likely have reduced this bias. In addition, it should be noted that participants in this study (as in most research studies) are healthier than their community-dwelling peers.[7] We did not observe any differences between African-American and white participants in factors associated with remaining disease free. However, the African-American cohort was smaller, with less follow-up time, resulting in fewer events in that group. The lack of a beneficial association of HRT use in older women differed from our *a priori* hypothesis. The lack of an HRT-effect association with remaining disease free may be true in older women or, alternatively, a true HRT association may be confounded by an indication bias—higher-risk women are placed on HRT—or by women using HRT having greater access to medical care and hence being more likely to have an earlier diagnosis. This confounding may occur despite efforts to confirm morbid and mortal events by obtaining hospital records, physician information, and death certificates.

Aspirin use was associated with a decrease in the probability of remaining healthy. We have previously documented the increased risk of stroke in aspirin users in CHS.[18] In addition, this association may represent an indication bias for aspirin use, in that individuals at higher risk for CVD events may be more likely to use aspirin at the baseline examination or that participants using aspirin may have other diseases (e.g., arthritis).

IMPLICATIONS

These data suggest that specific behavioral factors and medical interventions are associated with continued health in later life. A number of these factors are readily modifiable or amenable to treatment. Remaining physically active, refraining from cigarette smoking, consuming moderate amounts of wine, and maintaining weight are important individual preventive strategies that were associated with remaining healthy in this large cohort of older adults. In addition, physician awareness and treatment of hypertension and hypercholesterolemia would be expected from clinical trial results to yield benefits of continued health in older adults.[27–30] Importantly, the associations observed are compatible with an active approach to maintaining healthy behaviors and risk factor modification that may be expected to enhance the number years of healthy living enjoyed by community-dwelling older adults.

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