Predictors of Healthy Aging: Prospective Evidence from the Alameda County Study

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Abstract: Long-term predictors of high levels of physical functioning were examined in a representative sample of Alameda County, California residents followed from 1965 through 1984. The cohort investigated in this study was born between 1895 and 1919, with survivors being age 65 to 89 at the time of follow-up. A scale of physical functioning was developed from a comprehensive set of questionnaire items which assessed the full spectrum of physical functioning. Those scoring in the top 20 percent, defined as healthy aging, were compared to the remainder of the cohort, including those who died and those with lower levels of functioning at follow-up. After adjustment for age and functional status at baseline, the following variables were predictive of high functioning at follow-up 19 years later: race (those not Black), higher family income level, absence of hypertension, absence of arthritis, absence of back pain, being a non-smoker, having normal weight, and consuming moderate amounts of alcohol. Sex did not predict high function because of the counterbalancing effects of higher survival in females but greater likelihood of high functioning among surviving males. (*Am J Public Health* 1989; 79:703–708.)

Introduction

There have been dramatic improvements in life expectancy in this century, and mortality declines in the population age 65 and above have contributed substantially to these gains in the past 40 years. An individual reaching age 65 can now expect to live an average of 17 additional years[1] and life expectancy for older persons is expected to continue to rise into the next century.[2] An important and unresolved issue is whether the postponement of death that results from declining mortality rates will be accompanied by a similar postponement in serious morbidity.[3–6] In epidemiologic studies of aging, therefore, there are enormous potential benefits in identifying factors which not only influence longevity but also promote survival in an independent, highly functional state of health.

Rowe and Kahn have recently proposed use of the term successful aging to describe the concept that decline in organ functioning and physiologic processes are not necessarily an inherent part of aging.[7] Extending this concept for the purpose of identifying the healthy older person is not a straightforward process, however. In one of the few studies which has attempted to operationalize the concept of healthy aging in a population of older persons, Benfante, Reed and Brody considered healthy aging to be present in a subset of the Honolulu Heart Study cohort which was disease-free at baseline and had no incident chronic diseases over a 12-year follow-up period.[8]

The assessment of functional capacity can also serve as a valuable indicator of positive outcomes in aging as well as an indicator of disability. This study examines one aspect of healthy aging, namely the maintenance of very high levels of physical functioning. The study begins in middle age and examines functional status almost two decades later.

Methods

Study Population

The population used in these analyses is a subsample of a study of adults in Alameda County, California, the study design and sampling for which have been reported in detail elsewhere.[9,10] In 1965, a representative sample of adults age 20 and older (16 if ever married) was selected. In total, 6,928 individuals completed an extensive questionnaire about their health and behavioral, social and psychological aspects of their lives. Respondents were again contacted in 1974 and in 1982/83 a random 50 percent sample of 1974 respondents was contacted. In 1984, interviews were conducted with those individuals who were born prior to 1920 and who had completed the 1982/83 questionnaire.

The current analyses are limited to the cohort born between 1895 and 1919, who were age 65 to 89 at follow-up in 1984 or who died prior to that time. To be eligible for the 1984 survey, participants had to have been selected in the 50 percent random sampling of the cohort done for the 1982/83 survey. The analytic cohort for this study includes all those participating in the 1984 survey, all those dying between 1982 and 1984, and a random 50 percent sample of those dying between 1965 and 1982. This cohort consists of 841 individuals, of whom 345 (41.0 percent) died prior to 1984. Of the 496 survivors for whom an interview was completed in 1984, a proxy respondent was required for 31 (6.3 percent) due to a physical or cognitive disability.

In the 1965 baseline sample, 2,392 persons were born between 1895 and 1919. By 1974, 319 (13.3 percent) were known to have died. Of those remaining, 1,677 (80.9 percent) completed the 1974 questionnaire, 346 (16.7 percent) were located but did not respond, and 50 (2.4 percent) were not located. In 1982, 837 of the 1,677 persons responding in 1974 were randomly selected for follow-up. Between 1974 and 1982, 144 deaths occurred in this group (17.2 percent). Of the remaining 693 persons, 565 (81.5 percent) completed the questionnaire, 85 (12.3 percent) were located but did not respond, and 43 (6.2 percent) were not located. By 1984, 27 deaths occurred in the 1982 respondents (4.8 percent). Of the remaining 538 persons, 496 (92.2 percent) completed the 1984 interview, 30 (5.6 percent) were located but not successfully interviewed, and 12 (2.2 percent) were not located.

Those not located and those who were located but refused to participate were different from the cohort analyzed in this study in respect to several baseline variables. Among those born between 1895 and 1919, the group lost to follow-up tended to be younger at baseline than those successfully followed (60.2 percent of the group not located were ages 46–55, compared to 62.2 percent of the located nonrespondents and 51.6 percent of the analytic cohort). Persons lost to follow-up were more likely to be Black (Blacks comprised 19.4 percent of the group not located, 18.8 percent of the located

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nonrespondents, and 14.3 percent of the analytic cohort) and had lower family incomes (those classified as having inadequate or marginal incomes at baseline comprised 36.4 percent of the group not located, 25.8 percent of the located nonrespondents, and 22.5 percent of the analytic cohort).

Outcome Status

Mortality—Deaths were ascertained through a computer-matching procedure with the California Death Registry.[11,12] Additionally, extensive in-state and out-of-state tracing was done in 1974 and 1982 for participants not responding to questionnaires.[9] For previously unascertained deaths which were reported by next-of-kin or others at the time of the 1984 survey, death certificates were requested for confirmation.

Physical Functioning—The 1984 interview contained an extensive section on physical functioning and disability, including basic activities of daily living, instrumental activities of daily living (doing housework and shopping), and more vigorous physical functioning (difficult household tasks, exercise and recreational activities). To assess the full spectrum of functioning and identify those in the cohort functioning at the highest levels, a comprehensive, summative scale was constructed. Selection of appropriate questionnaire items for this scale was accomplished by entering variables representing all items related to physical functioning into a principal factor analysis using oblique rotation.[13,14] A large number of the items loaded on the first two factors (see Appendix), which were the only factors with eigenvalues greater than 1.

Scales of basic functioning and exercise were created using items loading on the first and second factors, respectively. All items in the basic function and exercise scales were then combined to create a summary scale of functioning. While these factors represent different constructs, the scales were combined because of the underlying correlation of the two factors (reference axis correlation = .33) and because of the clear hierarchical relationship of these scales. None of those with poor scores on the basic function scale had high scores on the exercise scale while those with high scores on the exercise scale all had very high scores on the basic function scale. Cronbach's alpha was .90 for the combined scale. The distribution of scores on the combined scale is shown in Figure 1. Scores on this scale ranged from 0 to 92, with a median of 72, a mean of 68.5 and a standard deviation of 15.0. Those scores of 80 and above represent the top quintile of scores. Individuals in this group are classified as having high functioning for the purpose of the analyses to be presented here.

Baseline Variables

Data on demographic factors, chronic conditions, and health-related practices examined in these analyses were obtained from responses to the baseline 1965 questionnaire. Health-related practices examined in these analyses were those previously demonstrated in the Alameda County Study to be associated with increased probability of survival in younger[9] and older[15] persons.

Because not all participants began the study in 1965 with the same level of physical functioning, it was necessary in multivariate analyses to adjust for baseline functional status. Ideally, the same scale used in 1984 would be used to assess 1965 functional status, with this scale score being entered as an independent variable in all analyses. However, the variables making up the 1984 combined function scale were not all collected at baseline. For those variables which were collected in both 1965 and 1984, an abbreviated scale of functioning was empirically developed which, using 1984 data, had a .80 correlation with the full, 1984 combined

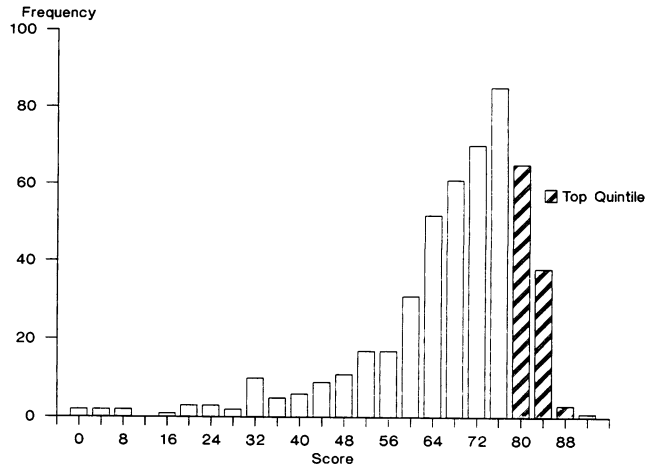

FIGURE 1—Distribution of Scores on the Combined Function Scale

function scale. In practice, this scale, using 1965 data, was entered into models as two variables, one containing basic functioning items and the other containing exercise-related items. In all models which were constructed, these 1965 variables remained highly significant predictors of high functioning in 1984. The inclusion of chronic conditions in the full models to be presented also provides an additional adjustment for health status at baseline.

Statistical Analyses

Analyses compare those in the highest quintile of scores on the combined scale of physical functioning with the remainder of their cohort, including those who died prior to follow-up. Multiple logistic analysis is used to assess the multivariate associations of baseline variables with outcome while simultaneously adjusting for age, race, sex, and baseline functional status. Parameters of the logistic function were determined using the iterative maximum-likelihood technique as described by Walker and Duncan.[16]

In the first set of analyses, the high function group is compared to all other members of the cohort, nearly half of whom had died prior to the follow-up. To investigate the possibility that significant associations found in the first set of analyses resulted simply because of the strong, well-recognized associations of many of the baseline variables with mortality, multiple logistic models using a trichotomous outcome were constructed. This allowed, in one model, for the separate analyses of associations between baseline factors and: 1) the outcome high function versus deceased, and 2) the outcome high function versus moderate to low function. These analyses were accomplished using the CATMOD procedure of SAS, modified for logistic regression.[17] This procedure uses the maximum-likelihood estimation method and yields the same results as the SAS LOGIST procedure when using a dichotomous outcome variable, but has the advantage of being applicable to polychotomous outcomes as well.

Results

Among the 841 individuals in the cohort under study, there were 496 survivors (59.0 percent) at follow-up in 1984. Of these 496 survivors, there were 107 with scores at follow-up of 80 and above on the combined function scale. This high function group comprised 12.7 percent of the original cohort of 841 persons, with low to moderate function survivors comprising 46.3 percent and decedents 41.0 percent.

Results that follow will focus on the relation of baseline states to the outcome of interest, high functioning. For those in the study cohort (including decedents) reporting no high blood pressure at baseline, 14.9 percent went on to be in the high function group 19 years later as compared to only 2.1 percent in the group reporting high blood pressure (Table 1). Those reporting no heart disease, chest pain, shortness of breath, diabetes, arthritis, joint swelling, pain or stiffness and back pain were also significantly more likely to have high functioning at follow-up than those reporting these conditions. There was a low prevalence of self-reported diabetes, stroke, and cancer at baseline, but it is of interest that no one reporting these conditions had high function at follow-up.

For demographic variables, the proportion with high function at follow-up was significantly higher for younger individuals, those not Black, those with very adequate or adequate income, and those married at baseline (Table 2). Among the health practices, non-smoking, having moderate weight, moderate alcohol consumption, and eating breakfast regularly were all significantly associated with high function at follow-up. Physical activity was not studied as an independent variable because many of the items in this scale are incorporated in the scale used to adjust for baseline functional status in multivariate models.

Models are presented in Table 3 which evaluate demographics, chronic conditions, and health practices in three separate analyses, all adjusted for age, race, sex, and baseline functional status. As in the previous results, sex is not predictive of high function. Marital status is unimportant when adjusted for other demographic variables and baseline function, while the importance of age, race, and family income remains. Of the chronic diseases, the reported absence of high blood pressure and arthritis are clear predictors of high function, with back and chest pain being somewhat less so. Being a past or never smoker and having moderate body weight are associated with high function. Those with moderate alcohol intake were 2.4 times more likely to have high function at follow-up than abstainers and 1.7 times more likely to have high function than heavy drinkers. Eating breakfast, hours of sleep, and snacking were not associated with high function in this model. The strengths of association and 95 percent confidence intervals (CI) of all variables entered into a combined model showed little difference from the individual models.

Table 4, based on the trichotomous logistic model, demonstrates the association of baseline variables with three levels of outcome in 1984: high function, low to moderate function, and deceased. For example, those with no high blood pressure at baseline are 6.7 times more likely to end up in the high function group as in the deceased group and 4.1 times more likely to be in the high function group at follow-up compared to the low to moderate function group. Variables shown to be predictors of high function in previous models continue to be predictors of high function when compared both with dying during follow-up and with low to moderate function at follow-up.

TABLE 1—Percent of Cohort (Including decedents) with High Function at Follow-up According to Baseline Chronic Conditions: Alameda County Study

Chronic conditions (past 12 months)		
High blood pressure	No	14.9
	Yes	2.1
Heart disease	No	13.5
	Yes	1.9
Chest pain	No	13.9
	Yes	4.9
Shortness of breath	No	13.8
	Yes	5.9
Swollen ankles	No	13.5
	Yes	9.2
Leg cramps	No	13.4
	Yes	10.3
Stroke	No	12.9
	Yes	0.0
Bronchitis	No	12.6
	Yes	15.1
Asthma	No	12.7
	Yes	16.0
Diabetes	No	13.2
	Yes	0.0
Cancer	No	13.1
	Yes	0.0
Arthritis	No	15.6
	Yes	4.6
Joint swelling/pain/stiffness	No	14.4
	Yes	8.5
Back pain	No	14.5
	Yes	7.8

TABLE 2—Percent of Cohort (Including decedents) with High Function at Follow-up According to Baseline Demographic Characteristics and Health Practices: Alameda County Study

Demographic Characteristics		
Age (Baseline/Follow-up)	46–49 / 65–68	20.9
	50–59 / 69–68	15.0
	60–70 / 79–89	4.1
Sex	Male	13.9
	Female	11.7
Race	Not Black	14.3
	Black	3.3
Family Income	Very adequate-adequate*	16.2
	Marginal-inadequate	2.8
Current Marital Status	Married	14.6
	Not married	6.3
Health Practices		
Smoking	Past-Never	15.6
	Current	8.6
Relative Weight	Moderate**	14.4
	Other	6.3
Alcohol Consumption (drinks month)	None	7.0
	1–60	15.1
	>60	11.6
Eating breakfast	Regularly	14.1
	Sometimes-rarely	7.7
Hours of Sleep Per Night	7–8	13.5
	<7 or >8	10.2
Snacking	Rarely-never	14.2
	Sometimes-always	12.1

*Total household income adjusted for household size and scored in comparison to federal standards for 1965.

**Weight within 10% under and 30% over ideal weight according to Metropolitan Life Insurance 1959 standards.

Discussion

We used physical functioning as a measure of outcome, a departure from the usual disease-specific outcome in epidemiologic studies. There are numerous theoretical and practical advantages in characterizing older persons according to their level of functioning.[18] While it is certainly desirable to age with no chronic diseases, it can be problematic to characterize healthy aging according to diagnosed diseases. How important or severe must a disease be to remove someone from the healthy aging group? How intensively must we search for disease in order to declare someone disease-free? It is common for individuals who have chronic diseases but who are well compensated to live long, active, and vigorous lives, an outcome to which we all aspire. It is this outcome which is addressed in these analyses.

TABLE 3—Multiple Logistic Models Showing Association between Demographic Characteristics, Chronic Conditions and Health Practices and High Function at 19 Years: Alameda County Study

		Odds Ratio (95% CI) Demographic Model*	*Odds Ratio (95% CI)** Combined Model*
Age (10 years)	Younger/Older	2.3 (1.6, 3.5)	2.9 (1.9, 4.6)
Sex	Male/Female	1.2 (0.7, 1.9)	1.2 (0.7, 2.0)
Race	Not-black/Black	3.4 (1.2, 9.8)	2.9 (1.0, 8.7)
Family Income	Very adequate- adequate/ Marginal-inadequate	4.0 (1.5, 10.8)	4.0 (1.4, 11.2)
Current Marital Status	Married/Not married	1.3 (0.6, 2.7)	
		Chronic Condition Model	
High Blood Pressure	No/Yes	4.9 (1.4, 16.7)	4.3 (1.2, 15.1)
Heart Disease	No/Yes	1.1 (0.1, 10.2)	
Chest Pain	No/Yes	2.3 (0.7, 7.5)	
Shortness of Breath	No/Yes	1.1 (0.5, 2.8)	
Arthritis	No/Yes	2.6 (1.1, 6.0)	2.8 (1.3, 6.0)
Joint Swelling/Pain/Stiffness	No/Yes	1.0 (0.5, 1.9)	
Back Pain	No/Yes	1.9 (1.0, 3.6)	2.0 (1.1, 3.8)
		Health Practices Model	
Smoking	Past-Never/Current	2.8 (1.6, 4.8)	3.0 (1.8, 5.1)
Relative Weight	Moderate/Other	2.4 (1.1, 5.2)	2.3 (1.1, 4.9)
Alcohol/Consumption	1–60/None	2.4 (1.2, 4.8)	2.1 (1.1, 4.1)
(drinks/month)	1–60/>60	1.7 (0.6, 5.0)	1.7 (0.6, 5.1)
Eating Breakfast	Regularly/Sometimes-rarely	1.5 (0.7, 3.1)	
Hours of Sleep	7–8/<7 or >8	0.9 (0.5, 1.7)	
Snacking	Rarely-never/ Sometimes-always	1.3 (0.8, 2.1)	

*Demographic, chronic condition and health practices models: odds ratios adjusted for age, race, sex, baseline functional status and all variables in the model.

**Combined model: odds ratios adjusted for baseline functional status and all variables in the model.

In choosing an outcome of functioning rather than disease status, it is important to recognize that predictors of functional status identified in this study have their influence on function through specific diseases as well as patterns of accommodation and adaptation to these diseases. However, there are important gaps in our understanding of these pathways from disease to disability in older persons.[19] Using functioning as an outcome measure does not deny the importance of these pathways, it simply uses function as an overall measure of the impact in the older person of multiple diseases, conditions, and environmental influences.

The outcome measure in this study was a summative scale created from a large group of questionnaire items representing activities with a wide spectrum of difficulty. It was created to identify participants who were not only non-disabled but were also functioning at a high level. Nevertheless, it has a number of limitations. It assesses only physical functioning and does not take into account the domains of cognitive or psychological functioning directly. Many of the items querying activities of daily living and more difficult tasks have a large cognitive component, however, and it is likely that an individual with moderate to severe dementia would have difficulty with at least some of these activities and not score in the top quintile. The distribution of scores on this scale was unimodal, so the classification of the top quintile as representing high function was somewhat arbitrary. Scores on a summative scale, as opposed to a hierarchical scale, can be obtained in a number of different ways and it can be difficult to interpret what a particular score means. However, the construction of the scale as it was done here allows for a good characterization of those classified as having high function. To obtain a score in the top quintile, individuals had perfect or near perfect scores on the basic function component of the combined scale and reported engaging in at least some of the more vigorous activities on the exercise component.

The difficulty in tapping the high end of the functional spectrum using questionnaire items may have led to misclassification of individuals on the outcome measure used here. Those with no opportunity or inclination to engage in more vigorous activities, but who might have the capacity to perform them, would have scores below the top quintile and would not be classified as having high functioning. This potential misclassification could be a source of bias affecting our findings that both income and race are strongly associated with high function. To evaluate this, an analysis was performed using the basic function scale alone as the outcome. Employing this scale as a continuous variable and studying survivors, both income and race were found to be strongly associated with this outcome, even after adjusting for all other significant variables in a multiple linear regression model.

A number of other factors known to be associated with all-cause mortality and specific diseases were demonstrated in this study to be predictive of high function. These include smoking status, relative weight, alcohol consumption, and blood pressure. Physical activity has traditionally been one of the seven health behaviors studied in the Alameda County cohort, but it cannot be studied here as a predictive variable because it is part of both the outcome variable and the baseline adjustment variable. In all multivariate models, the baseline exercise variable is significantly associated with high function at outcome. While it is not correct to infer that it is causally related to high functioning, its association with high functioning offers evidence that those with high levels of physical activity at baseline continue to have high physical activity at follow-up. Arthritis and back pain—factors usually associated with disability but not mortality—remain significant predictors of high function after adjustment for many other chronic conditions, demographics, and health practices. Interestingly, in the logistic model with a trichotomous outcome, the absence of arthritis and back pain predict survival with high function versus mortality as well as

TABLE 4—Multiple Logistic Models Showing Association between Demographic Characteristics, Chronic Conditions and Health Practices and 19-Year Status (High function, Low/moderate function, deceased)*

		High function vs Deceased	High function vs Low/moderate function
		Odds Ratio (95% CI)	Odds Ratio (95% CI)
Demographic Model			
Age (10 years)	Younger/Older	5.1 (3.2, 8.0)	1.5 (1.0, 2.3)
Sex	Male/Female	0.5 (0.3, 0.8)	1.2** (0.7, 1.9)
Race	Not-black/Black	4.1 (1.4, 12.4)	3.1 (1.1, 9.3)
Family Income	Very adequate-adequate/ Marginal-inadequate	4.9 (3.0, 8.2)	3.1 (1.4, 10.2)
Chronic Conditions Model			
High Blood Pressure	No/Yes	6.7 (1.9, 23.8)	4.1** (1.2, 14.1)
Arthritis	No/Yes	2.4 (1.1, 5.3)	3.0 (1.4, 6.5)
Back Pain	No/Yes	1.9 (1.0, 3.7)	2.0 (1.1, 3.6)
Health Practices Model			
Smoking	Past-Never/Current	6.1 (3.3, 8.3)	2.2** (1.3, 3.8)
Relative Weight	Moderate/Other	2.6 (1.1, 6.1)	2.4 (1.1, 5.1)
Alcohol Consumption	1–60/None	3.1 (1.5, 6.5)	2.2 (1.1, 4.4)
	1–60/>60	2.5 (0.7, 8.2)	1.3 (0.4, 4.0)

*Odds ratios adjusted for age, race, sex, baseline functional status and all variables in model.
**For this variable, the odds ratio for high function vs low/moderate function is significantly different from the odds ratio for high function vs deceased at $p < .05$.

survival with high function versus low to moderate function.

An important finding in this study is that in analyses in which the high function outcome group is compared to the remainder of the cohort, sex is not a predictor of high function; the logistic analysis with trichotomous outcome suggests the reasons: females are more likely to be in the high function group when comparing this group with decedents, but among survivors males have a greater likelihood of being highly functional. Sex did not predict function at older ages because of the poorer survival in males and the poorer functional outcome in surviving females compared to surviving males. This is compatible with the findings of Katz and colleagues who found, in a cohort of persons already age 65 and older, that differences in average remaining disability-free years between males and females in different age groups were quite small and did not reflect the large differences in remaining life expectancy at these ages.[20]

There are no other prospective studies with long-term follow-up which provide data on how factors assessed in a cohort which is middle-aged at baseline predict high function when the survivors have passed age 65. In their study of factors associated with remaining disease-free in Japanese men ages 46–69 at baseline, Benfante, Reed and Brody found that systolic blood pressure, total cigarettes smoked, body mass index, and alcohol consumption measured at baseline were all inversely related to remaining disease-free at follow-up 12 years later.[8] In analyzing the effect of alcohol intake, they found the highest probability of remaining disease-free among alcohol abstainers, in contrast to our finding that moderate drinkers had a higher probability than abstainers of having high function at follow-up. Their physical activity index was not predictive of remaining disease-free.

Several studies have explored the relation of risk factors to the development of disability. Pinsky and colleagues used the Framingham Heart Study to investigate how traditional risk factors for heart disease predict disability in a subsample of survivors who remained free of diagnosed cardiovascular disease.[21] Ever having hypertension was predictive of disability in both men and women and elevated body mass index was predictive in women, but cigarette smoking was not associated with disability. Palmore studied demographic predictors of disability in a cohort followed for approximately 10 years, whose surviving members were age 72 and older at follow-up.[22] Adjusting for baseline disability, only age and a scale of physical health (measured in terms of disease presence and severity) were significant predictors of disability at follow-up. Sex, race, marital status, education, and income were not independent predictors of disability. Branch investigated incident disability in a cohort of persons age 66 and older who were followed for five years.[23] A number of health practice variables similar to those used in the Alameda County Study were evaluated. Slowed down activity in women and current or past smoking in men were the only variables predictive of disability in this study. It is of interest that the latter two studies, in which cohorts were already at older ages at baseline, found few variables predictive of disability.

One limitation of the present study is the selective loss during the follow-up period of more persons in the younger part of the study population, more Blacks, and more individuals with low family income levels. These losses are likely to bias the estimation of overall levels of physical functioning in 1984. However, specific risk estimates would be biased only if the associations of baseline risk factors with the outcome were different for those lost to follow-up and those remaining in the cohort. Because individuals who are lost to follow-up tend to have poorer outcomes than those who remain, it is likely that the inclusion in the study of those Blacks and low income individuals who were lost would have resulted in even stronger associations of race and income with functional outcome.

Findings in this study should also be interpreted in light of the potential changes in the baseline variables during the long follow-up period. In certain cases it is advantageous to measure risk factors during middle age. Assessing income at older ages may not give a valid picture of income during the pre-retirement years, so our baseline measure of income has particular advantages. However, some variables likely to change significantly after their baseline assessment may not reflect status during majority of the follow-up period. As an example, marital status as reported at baseline, which was not a significant predictor of high functioning, may not have been a good measure of marital

status during the 19 years of follow-up. In an older population such as this, many individuals married at baseline may have been widowed in the first few years of follow-up.

It is also doubtful that a single report of high blood pressure at baseline was representative of blood pressure status during the long follow-up period. Misrepresentation of blood pressure status could result from unreliable reporting, the use of antihypertensive medications, which was not assessed at baseline, the degree of blood pressure control and the development of hypertension after the baseline assessment. This type of misclassification would lead to a conservative bias in assessing the association of blood pressure with high function. Indeed, it is striking that a single question about high blood pressure asked 19 years prior to assessing function was so highly predictive of high function. These findings, along with those of Benfante and colleagues and Pinsky and colleagues, indicate that absence of hypertension may be one of the most important predictors of healthy aging. The benefits of hypertension control on cardiovascular disease are well documented.[24–26] Studies to assess how hypertension control affects overall health status and disability in older persons have not been done and would be very valuable.

As mortality rates decline and the average age at death is postponed, there will be a marked expansion in overall population morbidity levels if the onset of disease and disability is not postponed an equal or greater number of years. It is clear that in the next century the older population will survive longer and grow to unprecedented size. The findings from this study indicate the possibility that active intervention in areas which promote healthy aging might lead to an aging population which retains high levels of function for a longer proportion of their lives and is therefore less dependent on their families and the health care system.

APPENDIX

This list summarizes items loading on factors 1 and 2. The first factor contains items which mostly relate to basic functioning, that is, activities necessary in day-to-day life. Loading heavily on the second factor were items related to exercise. Miscellaneous items loaded on a third factor and were dropped from further scale construction. The grouping pattern of items on the first two factors was understandable and in general reflected what one might have constructed *a priori*. These two scales were therefore retained and items were given equal weighting in the creation of summary measures.

Factor 1—Basic Function Scale

Activities of daily living: bathing, grooming, dressing, eating, transferring from bed to chair, using the toilet
Walking across a small room
Climbing stairs
Walking one-half mile
Pushing or pulling a large object
Stooping, crouching, kneeling
Lifting and carrying weights over 10 pounds
Gardening
Meal preparation
Heavy housework
Difficulty getting places
Shopping

Factor 2—Exercise Scale

Any sports exercise
Walking for exercise
Exercising long enough to sweat
Calisthenics or stretching to exercise
Swimming
Vigorous exercise: jogging, bicycling, aerobics, tennis, dancing, hiking

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