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Factors Associated With Change in Physical Functioning in the Elderly:

A Six-Year Prospective Study

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This study analyzes risk factors associated with 6-year change in physical functioning for 356 members of the Alameda County Study aged 65 and over. Statistically significant associations were found for baseline age, family income, perceived health, number of chronic conditions, prevalent stroke, prevalent heart attack, exercise, going out, marital status, social networks, depression, and internal health locus of control. Relatively strong (but not statistically significant) associations were found for ethnicity, smoking, and weight. Incident conditions during follow-up that had statistically significant associations with change in function included hip fracture, stroke, serious fall, and heart attack. Controls for prevalent and incident conditions attenuated the associations for only ethnicity, smoking, weight, and marital status. Interventions directed at the risk factors identified here may hold promise for extending independent physical functioning in old age.

The unprecedented changes that have occurred in the age structure of the United States and many other populations have increased interest in how to maintain quality of life and autonomy with aging. This issue extends far beyond the mere extension of life, because the wish is to

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add "life to years," not just "years to life." Such interest in quality of life while aging is at the heart of the compression of morbidity debate (Kaplan, 1991).

One consequence of the shift from a sole concentration on extension of life is increased attention to levels of functioning among the elderly. Epidemiologic attention to functional health status during the later years is relatively new (Guralnik, 1985; Jette & Branch, 1981; Nagi, 1976). Generally speaking, functional health status is a measure of the ability of an individual to carry out activities that are related to "normal" levels of functioning. Often functional health measures assess difficulties in carrying out the most basic functions such as activities of daily living (ADLs) related to self-care, eating, or moving around (Jette & Branch, 1981; Katz & Apkom, 1976). However, assessment of higher levels of functioning (e.g., lifting 10 pounds or shopping) or functioning in a variety of domains (e.g., marriage or work) is also possible (Branch & Jette, 1981; Lawton & Brody, 1969; Nagi, 1976; Rosow & Breslau, 1966). The broadest definition of functional status would include assessing a full range of physical, social, cognitive and psychological functioning.

Although uniform declines in functional status were often thought to accompany aging, there is now increasing evidence of considerable heterogeneity in levels of functioning at all ages, laying the grounds for preventive approaches. In addition, a small but increasing body of evidence points to considerable plasticity in functioning (Manton, 1988; Strawbridge, Kaplan, Camacho, & Cohen, 1992). For example, Manton (1988) found that for those with one to two ADL problems at baseline, approximately the same percentage of survivors improved as worsened over the next 2 years. Similarly, Strawbridge et al. (1992) found in a 6-year follow-up of persons aged 65 or older that 13% of those with ADL problems at baseline who survived were independent at follow-up, and 23% of those with mobility impairments were no longer impaired.

The present study examines the association between demographic, health, behavioral, social, and psychological risk factors and changes in physical functioning. Physical functioning is important because it provides a substrate for many of the activities considered essential to independent living. In addition, many of the measures of physical

functioning also involve considerable cognitive, social, and motivational components. Although several studies have examined changes in physical functioning (Branch, 1985; Harris et al., 1989; Keil et al., 1989; Lammi et al., 1989; Mor et al., 1989; Pinsky, Leaverton, & Stokes, 1987), the present study provides the most comprehensive measures of demographic, health, behavioral, social, and psychological variables that potentially might be associated with changes in functional status.

Methods

SAMPLE AND SURVEY DESCRIPTION

The population used for this analysis is a subsample of the Human Population Laboratory's Alameda County study. Detailed design and sampling procedures are reported elsewhere (Berkman & Breslow, 1983; Hochstim, 1970). The original cohort of 6,928 persons was selected to be representative of the adult noninstitutionalized population of Alameda County in 1965 when the first interview was conducted. Surviving members were reinterviewed in 1974 and a representative 50% subsample was interviewed for a third time in 1983. Nursing home residents were included. Loss to follow-up was very small. All but 4.4% of those not known to be dead in 1974 were located and 82% of them were interviewed. In 1983, 94% of those not known to be dead were located, and 87% of them were interviewed. Detailed analysis of the 1974 nonrespondents compared to the 1965 respondents has shown that the likelihood of nonresponse bias is small (Wiley & Camacho, 1980).

In 1984, a special follow-up was undertaken to look in detail at functional abilities among the oldest surviving members of this cohort. The designated sample consisted of the 580 respondents who were 65 years old or older in 1984 and who had been interviewed in 1965, 1974, and 1983. Of that group, 30 died before the fieldwork could be completed, 12 could not be located, and 30 who were located declined to be interviewed. Completed interviews were obtained with the remaining 508. By 1990, there had been 127 confirmed deaths. Of the remaining 381 members of the 1984 cohort, all but 5 were located and

interviews were completed with 356 (20 declined to be interviewed). The proportion of the original 508 who could not be located or who declined to be interviewed was only 4.9%. Proxy respondents (nearly always spouses or adult children) were used for 35 interviews in 1984 and 38 in 1990.

All baseline items pertaining to health or functioning were collected in 1984. Psychological and social information was collected in 1983. A few of the demographic variables (such as age, gender, and ethnicity) were collected in earlier interviews.

INDEPENDENT MEASURES

Most of the baseline risk factors were based on measures shown in previous Alameda County Study analyses to predict subsequent survival of 1965 cohort members (Berkman & Breslow, 1983; Berkman & Syme, 1979; Kaplan, Roberts, Camacho, & Coyne, 1987). Many of these same measures were used previously in an analysis of long-term predictors of healthy aging using 1984 function as a dependent variable (Guralnik & Kaplan, 1989). Newly developed measures for the analyses presented here are described below.

The exercise scale contained five items: takes part in any sports exercise, walks for exercise, exercises long enough to work up a sweat, does calisthenics or stretches, and does any other vigorous exercise. Scoring for the first two items is *no* (0) or *yes* (4); the next two are scored *never* (0), *sometimes* (2), or *often* (4). The last item is scored 0 to 4 based on the number of other activities named and frequency of occurrence. Results are summed. The resulting scale had a range of 0 to 20, a mean of 8.0, and an internal consistency of .77 (standardized Chronbach's alpha).

The "going out" variable involved asking respondents how many days in an average week they went out to do things they enjoyed doing such as visiting friends or attending social events, movies, church activities, or sports. Scoring is from *never* (1) to *every day* (6).

Internal health locus of control is based on adding scores on two questions from the Multidimensional Health Locus of Control scale (Wallston & Wallston, 1978): "When I feel ill, I know it is because I have not been taking care of myself properly"; and "I am directly

responsible for my health." Respondents are asked how well each question describes them. Scoring is from *very well* (1) to *not at all* (4).

Data on a limited set of incident health conditions were collected by asking 1990 respondents if they had had the following since 1984: stroke, heart attack, emphysema/lung (chronic obstructive pulmonary) disease (COPD), cancer, serious fall, and broken/fractured hip.

DEPENDENT MEASURE: FUNCTION SCALE

The function scale we developed includes activities of daily living (ADLs), instrumental activities of daily living (IADLs), physical mobility, physical performance, and ability to get around. The ADL items include bathing, eating, dressing, using the toilet, walking, transferring from bed to chair, and grooming (Jette & Branch, 1981; Katz, Downs, Cash, & Grotz, 1970); IADL items are cooking, shopping, and housework (Lawton & Brody, 1969); the physical mobility items are walking a half mile and climbing up a flight of stairs (Rosow & Breslau, 1966); physical performance items are push/pull a large object, crouching/kneeling, lifting a 10-pound weight, lifting arms over the head, and picking up small objects (Nagi, 1976); and the getting-around item asked how much of a problem it was getting to places where the person wanted to go. This scale differs from the one used previously to analyze long-term predictors of 1984 physical functioning in this cohort by excluding gardening and exercise measures while including lifting arms over the head and picking up small objects.

The 18 items making up the scale were scored as follows. The ADL and physical performance measures were scored from *cannot do or need help to do* (0) to *have no difficulty doing* (4). Intermediate scores (1-3) were based on level of difficulty in doing the activity (a lot, some, a little). The three IADL items were scored *could not do any without help* (0), *able to do some but not all* (2), or *could do all without help* (4). How much a problem it was getting where one wanted to go was scored *do not go out or a big problem doing so* (0), *a little problem* (2), or *no problem* (4). The two mobility items were scored either *need help to do* (0) or *able to do without help* (4). The 18 items were summed. Internal consistency was .94 (standardized Chronbach's alpha) for the 1990 interviews (n = 356) and .93 for 1984 (n = 508). Higher scores indicate better functioning.

ANALYSIS

We first examined demographic and health characteristics of the 356 respondents. Next, we calculated change in function between 1984 and 1990 by subtracting the 1984 function score from the 1990 score. Then we used multiple regression to assess the impact of baseline variables and incident health conditions on change in function between 1984 and 1990. Finally, we compared the associations between the baseline variables and change in function with and without controls for prevalent and incident COPD, hip fractures, serious falls, stroke, and heart attack.

Throughout the analysis, we used a method recommended by Lee (1980) to perform regressions with a change score: The 1990 function scale was entered as the dependent variable, and the 1984 score was entered as an independent variable along with the predictor being examined. This procedure yields the same results as using the difference between the 1990 and 1984 function scores as the dependent variable and entering the 1984 score as a control variable along with the specific predictor. All equations were adjusted for age.

Although we used standard significance levels of .05, the relatively small sample size of 356 means that associations that are of borderline significance should not be summarily dismissed. To aid in interpreting our regression results, we report both coefficient size and exact probability values.

Results

Basic 1984 demographic and health data for the 356 respondents are presented in Table 1. Women made up 59% of the respondents; Blacks made up 12%. There were only 10 Hispanics, Asians, or other ethnic minorities in the sample, so we included them with Whites for subsequent Black/non-Black comparisons.

The two most prevalent chronic conditions reported were arthritis and high blood pressure, with females reporting a higher prevalence

Table 1
Sample Characteristics at Baseline (n = 356)

Characteristic	Total (n = 356) %	Males (n = 147) %	Females (n = 209) %
Age groupings			
65-69	41	44	39
70-79	49	51	47
80-95	10	5	14
Education			
High school graduate or more	66	71	63
Some high school	15	13	16
8 years or less	19	16	21
Marital status			
Married	68	86	56
Widowed	23	8	33
Divorced or separated	6	3	9
Never married	3	3	2
Ethnicity (Black)	12	10	14
Employed full or part time	16	22	10
Lives alone	20	8	28
Has arthritis	63	60	65
Has high blood pressure	37	32	40
ADL dependent (one or more)	6	3	9
Perceived health excellent or good	77	82	74

of either condition than males. Three percent of the males and 9% of the females reported at least one ADL dependency at baseline. About three fourths rated their health as good or excellent.

For 1984, the mean of the function scale for the 356 respondents was 67.9 with a standard deviation of 7.3. Six years later in 1990, the mean for these same persons was 62.3 with a standard deviation of 14.9. The mean drop over the 6-year follow-up was 5.6 points.

Distribution of the change in function score is shown in Figure 1. Although a majority of respondents did decline (55%), 27% remained the same and 18% improved.

BASELINE FACTORS ASSOCIATED WITH CHANGE IN FUNCTION

The results of analyzing the relationships between the baseline risk factors and change in function are presented in Table 2. Variables are grouped into five categories: demographic, baseline health, behavioral, social, and psychological. The change coefficient values in the table represent the mean reduction or increase in the 1990 function scale score for each 1-point change in the indicated independent variable holding 1984 function and age constant. For example, current smokers scored an average of 3.27 points less on the 1990 function scale than did former smokers or those who had never smoked, and each 1-point increase in the exercise scale was associated with an increase of 0.27 points on the 1990 function scale.

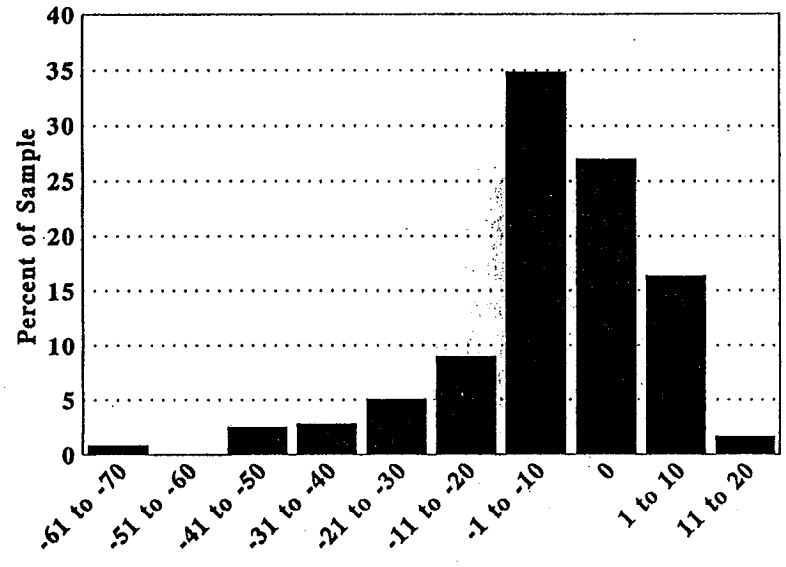

Figure 1. **Change in function score from 1984 to 1990 (n = 356).**

The only demographic risk factors associated with change in function were age and family income (the latter variable is adjusted for household size). A relatively large change coefficient of –2.06 was obtained for Blacks compared with non-Blacks, but the probability value was only .29. Despite the relatively large coefficient, the small number of Blacks in the sample leads to relatively imprecise estimates.

Baseline health risk factors significantly associated with change in function included perceived health, presence of one or more chronic conditions, previous stroke, and previous heart attack. The sign of the change coefficient for previous heart attack was not in the expected

Table 2
Baseline Characteristics Associated With Subsequent Change in Physical Function (n = 356)

Variable	Scoring (range)	Change coefficient	Probability
Demographic			
Age	Years (65-95)	-0.58	.01
Family income	Lowest/other	-4.45	.01
Ethnicity	Black/non-black	-2.06	.29
Education	8 years or less/other	-0.86	.60
Gender	Female/male	-0.11	.93
Baseline health			
Perceived health	Other/excellent	-3.32	.02
Number of chronic conditions	One or more/none	-3.39	.04
Stroke	Ever had/never	-5.93	.03
Heart attack	Ever had/never	+6.01	.03
COPD	Ever had/never	-2.54	.35
Hip fracture	Ever had/never	-1.74	.74
High blood pressure	Ever had/never	-0.38	.77
Diabetes	Ever had/never	+0.61	.82
Cancer	Ever had/never	+0.17	.95
Serious fall	Ever had/never	-0.10	.95
Hearing	Poor or fair/other	-0.08	.96
Vision	Poor or fair/other	+0.06	.97
Behavioral			
Exercise scale	5-item scale (0-20)	+0.27	.01
Going out	Number of days per week (1-6)	+1.38	.01
Smoking	Current/other	-3.27	.06
Weight	10% or more below/other	-3.92	.18
Social			
Social network index	Lowest score/other	-5.48	.02
Marital status	Separated or divorced/other	-5.02	.05
Psychological			
Depression	Any depressive symptom/none	-2.98	.04
Internal health locus of control	2-item scale (2-8)	+0.76	.04

Note. Change coefficients represent mean change in the 1990 function scale score for each 1-point change in the predictor variable, holding 1984 function and age constant.

direction. Further analysis (not shown) revealed that two of the persons with prevalent heart attacks suffered their attacks in the same year as their baseline interviews and scored relatively low on baseline

functioning, presumably as a result of their recent heart attacks. Six years later their combined scores had improved by 34 points. When those two persons were removed from the analyses, the relationship between prevalent heart attack and function was no longer significant. In addition, persons reporting prevalent heart attacks had stopped smoking at greater rates than had those without prevalent heart attacks.

Statistically significant behavioral risk factors included exercise and going out. In addition, the change coefficients for smoking and other-than-moderate weight were relatively large, with significance probabilities of .06 and .18 respectively. Social risk factors significantly associated with function included marital status and the social network index. Psychological risk factors included depression and internal health locus of control.

INCIDENT CONDITIONS ASSOCIATED WITH CHANGE IN FUNCTION

Incident conditions associated with change in function are shown in Table 3. All equations are adjusted for 1984 function and age. Comparisons in this table are between those who reported experiencing the condition between baseline and follow-up but who had not experienced it before and those who had never reported the particular condition at baseline or follow-up. For example, respondents who were stroke free at baseline who had a stroke during follow-up scored 14.04 points lower on the 1990 function scale than did those who remained stroke free at follow-up. Because persons reporting the condition at baseline are omitted, specific numbers of persons in each category are presented.

The largest difference in function was noted for incident fractured hips, although this condition affected only seven persons. In addition to strokes, other significantly lower scores were noted for falls serious enough to require hospitalization and heart attacks.

ADJUSTMENTS FOR PREVALENT AND INCIDENT CHRONIC CONDITIONS

Table 4 compares the associations that were at least marginally significant from Table 2 with those from a more complex model that

Table 3
Incident Health Conditions Associated With Change in Physical Function (n = 356)

Variable	Scoring (*n/n*)	Change coefficient	Probability
Hip fracture	Yes/no (7/343)	–25.88	.000
Stroke	Yes/no (17/315)	–14.04	.001
Serious fall	Yes/no (51/225)	–7.88	.000
Heart attack	Yes/no (16/315)	–7.12	.02
COPD	Yes/no (13/317)	–4.11	.20
Cancer	Yes/no (16/312)	–1.21	.69

Note. Change coefficients represent mean change in the 1990 function scale score for those reporting the incident condition for the first time during follow-up compared with those who had never reported it, holding 1984 function and age constant.

controlled for prevalent and incident COPD, hip fractures, serious falls, stroke, and heart attack. Cancer was not included as a control variable because of its weak relationships with function in both Tables 2 and 3. We made these comparisons to test for possible confounding between the risk factors and prevalent/incident chronic conditions. For ethnicity, smoking, weight, and marital status the multiple regression coefficients showed a marked reduction when the control variables were added. The coefficients for depression and the social network index showed a moderate reduction. For the other baseline risk factors the regression coefficients are similar, with or without the controls.

Discussion

In the current analyses, a variety of behavioral, social, psychological, and demographic risk factors were significantly associated with 6-year change in functional status. Many of these risk factors were also associated with risk of death in the Alameda County Study cohort (Kaplan, in press; Kaplan & Haan, 1989).

Not surprisingly, some of the most powerful predictors of declines in functioning were chronic conditions present at baseline or those that occurred during follow-up. It is possible that non-health-status factors may be associated with subsequent change in functioning only because they are also associated with baseline health status. Thus low baseline levels of physical activity and high baseline levels of depressive symptoms might be associated with subsequent declines in functioning because those who are sick are more likely to have lower levels of exercise and higher levels of depression than those who are not sick, and those who are sick are more likely to evidence a decline in functioning. However, the adjustment for baseline function level that we made in each model should capture such cross-sectional associations between baseline health status and other risk factors.

It is also possible that incident conditions could account for the association between baseline risk factors and decline in functioning. Here, the temporal relationships argue for the incident conditions as the pathway by which baseline risk factors are associated with change in functioning. Thus lack of exercise and smoking might lead to a

Table 4
Baseline Risk Factors Associated With Change in Physical Function With and Without Adjustments for Chronic Conditions (n = 356)

	Without adjustments		With adjustments[a]	
Variable	Change coefficient	(*p*)	Change coefficient	(*p*)
Demographic				
Age	–0.58	(.01)	–0.41	(.01)
Ethnicity	–2.06	(.29)	–0.09	(.96)
Family income	–4.45	(.01)	–4.02	(.01)
Baseline health				
Perceived health	–3.32	(.02)	–2.58	(.06)
Behavioral				
Exercise scale	+0.27	(.01)	+0.28	(.01)
Going out	+1.38	(.01)	+1.32	(.01)
Smoking	–3.27	(.06)	–1.93	(.25)
Weight	–3.92	(.18)	+0.01	(1.00)
Social				
Marital status	–5.02	(.05)	–2.54	(.29)
Social network index	–5.48	(.02)	–4.43	(.04)
Psychological				
Depression	–2.91	(.04)	–2.06	(.12)
Locus of control	+0.76	(.04)	+0.85	(.01)

Note. Change coefficients represent mean change in the 1990 function scale score for each 1-point change in the predictor variable, holding 1984 function and age constant.
a. Adjustments are for prevalent and incident COPD, hip fracture, serious falls, stroke, and heart attack.

myocardial infarction, which would then lead to a decline in function. To examine this possibility, we analyzed the demographic, behavioral, social, and psychological risk factors in a regression model that also included adjustments for prevalent and incident COPD, hip fracture, serious fall, stroke, and heart attack. Decreases in the associations between the risk factors and decline in function were found for four factors: ethnicity, smoking, weight, and marital status. Thus there is evidence that these factors are associated with subsequent declines in functioning partly because of their association with increased incidence of chronic conditions that in turn affect functioning. These adjustments should be viewed with some caution, however, because several associations were not significant before the controls were added.

It should not be surprising that a wide variety of behavioral, social, psychological, health status, and demographic risk factors are associated with changes in physical functioning. ADL activities, and certainly higher levels of functioning, represent a complex mix of physical and physiological capabilities and cognitive, social, and motivational factors. Multifactorial determination is to be expected.

The large variation in amount of change in physical functioning found in this and other studies coupled with the multifactorial determination of this change suggests reasons for optimism. Multifactorial interventions directed at the risk factors identified in these analyses may hold promise for extending active and independent functioning in old age. Such interventions may be one way to add life to years.

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