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"*Functional Ability in the Oldest Old*

Cumulative Impact of Risk Factors From the Preceding Two Decades"

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Cumulative Impact of Risk Factors From the Preceding Two Decades

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The authors studied the relationships between physical functioning and cumulative measures of behavioral and psychosocial risk factors collected over two decades for 91 persons 80 years old and older at follow-up. They found that consistency of physical activity and absence of depression were associated with better functioning as were race (non-Blacks), education, and marital status. A health practices index that combined consistency of moderate alcohol use, moderate weight, and physical activity was also associated with better functioning. Controlling for the persistence of chronic conditions generally reduced but did not eliminate the observed relationships. The association between social contacts and functioning became stronger in the presence of controls. Risk factors after age 60 appear to influence physical functioning for those who survive into their 80s and consistency appears to make a difference.

The "oldest old"—variously defined as those over age 75, 80, or 85—constitute the fastest-growing segment of the U.S. population; whereas in 1985, persons 85 years old and over comprised about 1% of the total population, the projection is that they will make up 5.2% by the year 2020 (Suzman & Riley, 1985). Historically, the image of

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the very old has been one of frailty; extensive loss of physical, social, and mental function; and heavy use of health care resources. Although this is indeed an accurate picture of some of the oldest old, we now know that there are many others who are able to maintain a high level of function at this age (Guralnik & Kaplan, 1989; Manton, 1989; Palmore, Nowlin, & Wang, 1985).

As the numbers in this oldest group grow, it becomes increasingly important to understand the factors that determine ability and disability at this age. Of particular and practical interest is if the accumulated effects of early and midlife behaviors, conditions, and disease irrevocably determine functional status after age 80 or whether individuals in their 60s, 70s, and 80s can still affect their own functional ability by managing discretionary risk factors.

Although studies of disability among the oldest old are still sparse, there is a growing body of work that has identified some of the factors related to functional ability in more broadly defined elderly populations, usually those age 60 and older. These factors include respondent characteristics of age, gender, marital status, and health status (Guralnik & Kaplan, 1989; Harris, Kovar, Suzman, Kleinman, & Feldman, 1989; Kaplan, 1992; Palmore et al., 1985; Roos & Havens, 1991; Seccombe, 1989; Verbrugge, Gates, & Ike, 1991; Verbrugge, Lepkowski, & Imanaka, 1989); socioeconomic indicators such as education, financial resources, and minority ethnic status (Harris et al., 1989; Keil et al., 1989; Linn, Hunter, & Linn, 1980; Mutchler & Burr, 1991; Palmore et al., 1985; Seccombe, 1989; Verbrugge et al., 1991; Victor, 1989); behaviors such as smoking, drinking, relative weight, and exercise (Branch, 1985; Guralnik & Kaplan, 1989; Harris et al., 1989; Keil et al., 1989; Mor et al., 1989; Pinsky, Leaverton, & Stokes, 1987); and social supports and affective states (Kaplan, 1992).

Unfortunately, much of the research on the elderly, especially that which includes the very old, suffers from limitations of cross-sectional design, extremely high rates of loss to follow-up, and/or exclusion of large segments of a sample on the basis of health problems or place of residence. Recent analyses of older members of the Alameda County study have avoided these problems by making use of a large sample with a long follow-up, very low loss to follow-up, and data that allow adjustment for previous health problems rather than exclu-

sion on that basis. These analyses provide strong evidence that a number of the demographic, social, and behavioral measures discussed above do predict functional level in old age among those who were middle-aged or older at the beginning of the study. For example, Guralnik and Kaplan (1989) showed that, among persons age 46 to 70 in 1965, high function 19 years later was associated with baseline measures of smoking, weight, and alcohol consumption even after adjustment for age and baseline functional status. Kaplan (1992) found that smoking, depression, weight, exercise, and social ties of persons age 50 to 86 at baseline were associated with both incident disease and incident disability over the next 9 years; he also reported that the impact of incident stroke, heart disease, and arthritis in terms of associated disability was modified by smoking status and presence or absence of depression at baseline. Finally, Kaplan, Strawbridge, Camacho, & Cohen (1993) have demonstrated that lack of exercise, few social contacts, and current smoking among persons age 65+ in 1984 are associated with significantly accelerated decline in functional status over the next 6 years.

In the analyses that follow, we build on this work with the Alameda County sample, narrowing our focus to those who were 80 years and over in 1984. Our intent is to (a) provide descriptive material on the characteristics and health of a very elderly sample, (b) examine the associations of demographic, socioeconomic, and health status characteristics with functional level, and (c) assess the cumulative effects of risk behaviors measured at three points in time over a 19-year period on functional status at age 80 and over.

Method

SUBJECTS

The respondents studied in this analysis are members of the Human Population Laboratory's Alameda County Study Sample. The original cohort of 6,928 persons was selected to be representative of the adult noninstitutionalized population of the county at the time of the first interview in 1965 and represents a response rate of 86% of the designated sample. Surviving members of the cohort were

reinterviewed in 1974 and a representative 50% subsample was interviewed for a third time in 1983. In this report, we refer to these first three interview points as Wave 1 (1965), Wave 2 (1974), and Wave 3 (1983).

In 1984, a special follow-up was undertaken with surviving three-time respondents who were then age 65 or older. Within this group of 508 individuals were 91 who were age 80 or older in 1984, and it is this group that is the focus of the present study. The response rate for this subsample was 100%. Further details of sampling procedures and characteristics of those lost to follow-up are reported elsewhere (Berkman & Breslow, 1983; Guralnik & Kaplan, 1989). An additional follow-up was conducted in 1990, but by then the number of survivors among those 80 years or older in 1984 had been reduced too much for reliable analyses.

MEASURES

Functional Status Measure

The 1984 questionnaire included a wide variety of questions about specific functional abilities and disabilities. In our earlier analyses with the full 1984 sample, 18 of these items were selected for inclusion in a scale of overall functional level (Strawbridge, Kaplan, Camacho, & Cohen, 1992). The items, specified in Table 1, measure degree of difficulty with 7 activities of daily living (ADLs), 3 instrumental activities of daily living (IADLs), 5 physical performance items, and 3 mobility items. Scores on the individual items range from 0 (*cannot do at all*) to 4 (*can do with no difficulty*), with intermediate scores indicating degree of difficulty or limitation of ability. The Function Scale score is computed by summing the scores of the 18 individual items. The scale has an internal consistency of .94 (standardized Cronbach's alpha).

Respondent Characterstics

Data on birth date, gender, ethnic identification, and educational level are from the 1965 baseline interview. Marital status is from the 1983 follow-up interview.

Table 1
Percentage of Respondents Experiencing At Least Some Difficulty on Scale Items

Item	% with at least some difficulty	*n*
ADLs		
Eating	4.4	4
Grooming	6.6	6
Transfer bed to chair	7.7	7
Using toilet	7.7	7
Dressing	11.0	10
Bathing	15.4	14
Walking	27.5	25
IADLs		
Cooking	26.4	24
Shopping	36.3	33
Heavy housework	55.0	50
Physical performance		
Manipulate small objects	13.2	12
Raise arms above head	15.4	14
Push/pull large object	23.1	21
Stoop/crouch/kneel	28.6	26
Lift 10 pounds	38.5	35
Mobility		
Climb stairs	26.4	24
Getting where want to go	41.8	38
Walk 1/2 mile	50.6	46

Respondents were asked about a broad range of medical problems at each of the interviews. For the analyses presented here, we were interested in these problems because they might affect any associations between functional status and other risk factors. Therefore, we included only those chronic conditions/events that were associated with functional disability in this sample, such as arthritis, high blood pressure, heart attack, stroke, and hip fracture. Questions about arthritis and high blood pressure were asked in 1965, 1974, and 1983. Questions on heart attack, stroke, and hip fracture were asked only in the 1984 interview, but included a question regarding the date of the first occurrence of each event; on this basis, we were able to code presence or absence of these events at each previous interview point. We then computed summary scores for Waves 1, 2, and 3 by a simple

count of the number of conditions and events reported at that wave. The final chronic conditions score consisted of a count of the number of waves at which one or more of these conditions were present.

Behavioral and Psychosocial Factors

Data on health practices, social networks, and depressive symptoms were gathered in identical form at each of the first three interview waves; the scores derived from these data have been described extensively elsewhere (Berkman & Breslow, 1983; Kaplan et al., 1993). For this analysis, the measures were dichotomized as follows:

Health practices: ever smoking versus never smoking; moderate alcohol consumption (1 to 45 drinks of alcohol/month) versus abstention or heavy drinking; medium or high levels of physical activity versus little or no activity, based on reported frequency of participation in active sports, swimming or walking, doing exercises, and gardening, with lesser weighting of the presumably less strenuous gardening item; Quetelet Index (weight in pounds/height in inches^2) no more than 9.9% below and no more than 29% above desirable weight versus all other, based on data from Metropolitan Life Insurance Company (1960); usually sleeps 7 to 8 hours per night versus sleeps less than 7 hours or more than 8 hours

Group memberships: member in a church group versus not a member; member in a nonchurch group versus not a member

Social contacts: reports 2 or more of the following: 3 or more close friends, 3 or more close relatives, see 3 or more friends or relatives at least once a month versus reports of one or none of these

Depressive symptoms: 4 or fewer depressive symptoms versus 5 to 18 depressive symptoms on the scale developed by Roberts and O'Keefe (1981).

Our analysis of the above behavioral and psychosocial risk factors also called for use of repeated measures to assess the effects of consistency or duration of the behavior on function. Initial analyses of behaviors reported at each of the three waves showed that there were no clear or consistent relationships of sleep patterns, smoking history, or church group membership to the 1984 function score; these variables were dropped from further analyses.

For those risk factors that appeared to have an association with follow-up functional status, summary scores were created in the form of a count of the number of waves at which the factor was in the positive (low-risk) category; these scores ranged from 0 (no low-risk report at any of the three waves) to 3 (low-risk report at all three waves). The physical activity, alcohol consumption, and relative weight items were also summed into an Index of Health Practices that ranged from 0 (high-risk behavior on all three items at all three waves) to 9 (low-risk behavior on all three items at all three waves). In subsequent analyses, categories of the summary scores were combined where small *n*s required it.

ANALYSIS

The first step in this analysis was to describe the extent of functional disability in the sample in terms of the overall functional status score and its individual components. We then examined variations in mean function score associated with the status characteristics and the behavioral risk factors discussed previously. Because both age and gender were strongly associated with the function score, we next used multiple regression analyses to examine the impact of the social and behavioral risk factors on functional ability, controlling for age and gender. Based on earlier studies indicating an association between chronic disease and functioning (Kaplan, 1992) as well as the likelihood that persistence of chronic conditions would be a strong predictor of functioning, we then included an adjustment for chronic conditions in the regression analyses and compared the regression results with and without the presence of this control variable.

Results

The variation in functional ability within the sample can be seen in the data presented in Tables 1 and 2. The proportion of the sample having at least some difficulty with an individual ADL (Table 1) ranged from a low of 4.4% for eating to a high of 27.5% for walking across a room. Among the instrumental tasks that caused difficulty, housework and walking a half mile rank highest—more than half of

Table 2
Functional Status Scores for Study Samples

Scale range	% within range	*n*
0-35 Low functioning	12.1	11
36-45	11.0	10
46-55	15.4	14
56-65	17.6	16
66-70	24.2	22
71-72 High functioning	19.8	18

the sample reported significant trouble with these. More than one third of the sample reported difficulty with getting to places they wanted to go, doing shopping, and lifting 10 pounds.

One out of five of these respondents achieved a function score of 71 or 72 (Table 2), indicating at most a little difficulty with only 1 of the 18 items. Another 24% scored between 66 and 70; thus nearly half of this very elderly sample were functioning reasonably well in terms of the physical management of their daily life activities. At the lower end of the scale, 12% scored below half of the total possible score, indicating rather severe impairment. Overall, the scale had a mean of 56.7 and a standard deviation of 16.4.

Table 3 shows the sample distribution and mean function scores by respondent characteristics. Both numbers of respondents and mean function scores declined steeply with increasing age. Women had somewhat lower mean function scores. This gender difference became less with adjustment for age and disappeared entirely with further adjustment for chronic conditions (data not shown). Nineteen percent of the sample were free of all five chronic conditions at all three interviews, while 2 out of 5 respondents reported at least one chronic condition at each wave. There was a steady decrease in function score as the number of interviews at which 1 or more of the chronic conditions were reported went from 0 to 3.

Blacks, who constituted 8.8% of the sample, had a much lower function score than non-Blacks, and those with less than 12 years of schooling (nearly half the sample) scored lower than those with more education. Married respondents scored higher than the more common

Table 3
Sample Distribution and Mean Function Score Differences by Respondent Characteristic

Characteristic	*n*	%	Function score	
			Mean	*p* value[a]
Age				
80-84	48	52.7	61.5	
85-89	31	34.1	53.0	
90+	12	13.2	46.7	.01
Gender				
Men	28	30.8	61.1	
Women	63	69.2	54.7	.09
One or more chronic conditions				
0 waves	16	19.0	68.0	
1 wave	12	14.3	58.3	
2 waves	22	26.2	57.8	
3 waves	34	40.5	52.9	.02
Ethnicity				
Black	8	8.8	43.1	
Other	83	91.2	58.0	.01
Education				
0-11 years	43	47.3	53.5	
12+ years	48	52.7	59.6	.08
Marital status				
Married	29	31.9	63.1	
Never married	7	7.7	60.0	
Formerly married	55	60.4	52.9	.02

Note. Numbers do not add to 91 in some categories because of missing data.
a. *p* values are based on one-way analysis of variance testing for differences between mean function scores within each category.

formerly married, but so did those few members of the sample who were never married.

Table 4 presents the distribution of the sample on the cumulative behavioral and psychosocial scores and the mean function scores associated with each cumulative level of these risk factors. The distributions of the health behavior scores reveal considerable variation within the sample and a fair amount of inconsistency of behavior over the 19-year period (indicated by respondents who report a given behavior at one or two interviews). There is less variation in social contacts and depressive symptoms; for each of these risk factors,

Table 4
Sample Distribution and Function Score by Behavioral and Psychosocial Risk Factors

Risk factor and frequency reported	*n*	%	Function score	
			Mean	*p* value[a]
Moderate/high physical activity				
0 waves	22	26.5	48.2	
1 wave	20	24.1	54.9	
2 waves	18	21.7	58.9	
3 waves	23	27.7	65.1	.01
Moderate alcohol use				
0-1 waves	35	38.9	52.1	
2 waves	21	23.3	57.0	
3 waves	34	37.8	60.8	.08
Moderate weight				
0-1 waves	26	28.6	51.5	
2 waves	18	19.8	54.0	
3 waves	47	51.6	60.6	.06
Health practices index score[b]				
0-3	15	18.1	48.1	
4-6	33	39.8	53.6	
7-9	35	42.2	63.6	.01
One or more group memberships				
0-1 waves	34	37.8	53.7	
2 waves	18	20.0	54.9	
3 waves	38	42.2	60.7	.16
Frequent social contacts				
0-1 waves	8	9.3	53.7	
2 waves	17	19.8	57.9	
3 waves	61	70.9	57.2	.84
Few depressive symptoms				
0-1 waves	12	13.3	46.6	
2 waves	22	24.4	51.0	
3 waves	56	62.2	60.9	.01

Note. Those missing data on any factor are omitted from that factor.
a. *p* values are based upon one-way analysis of variance tests.
b. Health practices index = sum of results for three previous risk factors.

approximately two thirds of the sample gave positive reports at all three waves.

For each of the health practices, the mean function score increased steadily with the number of positive reports. Of these, the greatest

spread in mean function scores was found for physical activity, where there was a 17-point difference in mean function score between those who reported adequate exercise at all three waves and those who reported it at none of the waves. There was also a very strong gradient of function score with increasing levels of the index score, which is a sum of the physical activity, alcohol use, and weight measures.

Associations of functioning with the cumulative number of positive reports of group memberships and social contacts were positive, but the differences in function score among the waves were less than for the health practices and the associated p values were not strong. For depressive symptoms, there was a strong and significant gradient of function scores associated with the increasing persistence of depressive symptoms.

Table 5 shows the results of 10 multiple regression analyses examining the associations between function scores and the same individual risk factors reported in Tables 3 and 4 with adjustments for age, gender, and with and without adjustment for the persistence of chronic conditions. As expected, the mean differences in function score were generally larger before the adjustment for chronic conditions, reflecting the fact that such conditions and their persistence are predictors of functioning. However, even in the presence of these controls there were strong and significant associations of functioning with ethnicity, education, the Cumulative Health Practices Index, and number of waves with high levels of depressive symptoms. The association of functioning with number of waves of physical activity was significant without controlling for chronic conditions, but was reduced to a mean difference of 2.6 ($p = .10$) when there was adjustment for chronic conditions. For two risk factors (marital status and social contacts), the associations with functioning increased with adjustment for chronic conditions, although the associated p values were between .05 and .10.

Discussion

The analyses presented here underscore the variation in functional ability among the very old with respect to individual tasks as well as overall functioning. Although poor functioning is a serious problem

Table 5
Regressions of Functional Status Score on Risk Factors Controlling for Age and Gender With and Without Controlling for Persistence of Chronic Conditions

Risk factor	Measurement	Mean difference in function score[a]	
		Controlling for persistence of chronic conditions[b]	Without controlling
Age, gender, and ethnicity	Blacks/other	−11.4 (.04)	−13.9 (.02)
Education	0-11 years school/ 12 years or more	−7.5 (.02)	−7.7 (.01)
Marital status	Formerly married/ married in 1983	−6.8 (.10)	−4.9 (.27)
Physical activity	number waves moderate or high activity/less	2.6 (.10)	3.7 (.02)
Alcohol consumption	number waves moderate consumption/other	2.9 (.11)	3.5 (.07)
Weight	number waves normal weight/other	2.2 (.25)	3.2 (.11)
Health practices index	Sum of above three measures	1.9 (.03)	2.5 (.01)
Group membership	number waves one or more memberships/none	2.3 (.20)	2.9 (.13)
Social contacts	number waves frequent contacts/less	4.7 (.06)	3.6 (.18)
Depressive symptoms	number waves few symptoms/more	5.2 (.02)	6.4 (.01)

Note. Seven persons with missing data on chronic conditions are omitted from this table.
a. *p* values in parentheses.
b. Control variable is number of waves with one or more chronic conditions.

for many of those age 80 and over, it is not an inevitable concomitant of a very long life. Nineteen percent of our sample were free of all five chronic conditions, and 20% achieved a perfect or near-perfect overall function score.

As expected, age and presence/duration of chronic disease account for a portion of the variation in functional ability, including most of the apparent excess disability of women over men. This is in contrast to some studies, including two longitudinal studies of the very old, that have shown greater disability for women (Palmore et al., 1985; Harris et al., 1989). However, neither of these last two studies controlled for

the prevalence of chronic conditions, and Palmore et al. did not control for age. Our findings are in accord with other studies that present evidence that the apparent increased female risk reflects the fact that women live longer with chronic conditions and associated disabilities than do men (Manton, 1989; Strawbridge et al., 1992).

The effects of socioeconomic status as measured by race and education are particularly strong in our sample, suggesting that the health disadvantage associated with minority status and low social class in younger populations persists into very old age. This phenomenon has been demonstrated in younger elderly populations (Linn et al., 1980; Mutchler & Burr, 1991; Seccombe, 1989; Verbrugge et al., 1991; Victor, 1989) as well as in studies of the very old (Harris et al., 1989; Palmore et al., 1985).

We find that the functioning of our very old respondents is influenced by the consistency of their behavior over the preceding 20 years: Regular physical activity, moderate alcohol consumption, and moderate weight, as well as the index combining all three of these health practices, appear to contribute to higher functioning. These findings extend behavioral associations previously noted for the younger elderly (Kaplan et al., 1993; Mor et al., 1989; Pinsky et al., 1987). Harris et al. (1989) reported a protective effect for the non-obese very old; our measure of moderate weight includes those moderately below or moderately above the mean and compares them with those at either extreme. Our analyses indicate that the effects of these behaviors are cumulative, with greater advantages for those who have been consistent. When adjustment is made for age, gender, and persistence of chronic conditions, the estimates of the effect of consistency of alcohol and relative weight become somewhat imprecise, but the relationship between the health practices index and functioning remains statistically significant.

For psychosocial factors, the consistency of high levels of depressive symptoms is strongly related to functioning with and without adjustments for age, gender, and persistence of chronic conditions. The persistence of group memberships maintains a positive association with functioning throughout the analyses, but the associations never reach statistical significance. The relationship between the persistence of social contacts and functioning strengthens as controls are added.

In sum, analyses presented here indicate that behaviors that have been identified as midlife risk factors for future health outcomes continue to be important well into old age; departures from healthy practices even among those already in their 60s or 70s are associated with decreased physical functioning. The major exception to this is that smoking status did not predict functional level among those surviving to age 80 and beyond. This result may be caused by differential survival among older smokers with the result that those smokers who do survive beyond age 80 are different on average from younger smokers in some way, such as the extent of their previous smoking history or in their resistance to smoking-caused morbidity. Small numbers may also be responsible: Only five of our respondents (5.5%) were still smoking in 1983. We have previously shown that smoking is associated with subsequent 6-year decline in physical functioning for a larger group of persons 65 years old or older at baseline (Kaplan et al., 1993).

In assessing the results presented here, certain cautions are in order. First, all information on behavioral risk factors and disability levels is based on self-reports that are not externally validated. However, previous Human Population Laboratory studies have shown the risk factors to be strong and consistent predictors of several different health outcomes in this sample (Berkman & Breslow, 1983; Wiley & Camacho, 1980), and we have found the 1984 functional status score to be strongly related to subsequent mortality (Strawbridge et al., 1992). Second, we do not have continuous information on risk factors over the 20-year study period, and there is certain to be some unmeasured variation in these variables in each of the 9-year intervals between our measurements. This situation necessitates caution in interpreting our measures of consistency. However, unmeasured variations in risk factors would likely dilute the effects of our cumulative measures on functioning, so that the actual associations may be more robust than our results indicate.

A more difficult problem of interpretation stems from the absence of information regarding behavioral risk factors during the earlier part of our respondents' lives. It seems likely that consistency of health habits in old age partly reflects the consistency of these same factors throughout life. If so, then it is possible that the effects on functioning

derive both from earlier behaviors and from those practiced in old age. Studies with access to relevant data over the entire life span are needed to establish the relative importance of early- and later-life factors on functioning in old age.

In this, as in most studies of behavioral risk factors and health outcomes, there is the possibility of reverse causation; that is, individuals who are already ill and/or disabled may not be able to engage in physical activities, make contacts with friends, and so on. However, in this group of survivors to age 80+, it is reasonable to assume a certain level of good health at baseline 19 years earlier; none of the sample reported problems with basic self-care items asked in 1965, and only two reported any mobility problems. Finally, we demonstrated that adjustment for the persistence of the chronic conditions most likely to limit functioning reduced but did not eliminate the relationships between functioning and the risk factors.

Despite a small sample size, these analyses have revealed strong associations of socioeconomic, behavioral, and psychosocial risk factors with physical functioning in old age. Furthermore, these effects appear to be cumulative over time. Such evidence that risk factors after age 60 influence the functional ability of those who survive for another 20 years carries important implications for education and prevention among older persons.

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