

# Antecedents of Frailty Over Three Decades in an Older Cohort

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*Studies of disability in old age have focused on gross measures of physical functioning. More useful results for prevention might be gleaned from examining risk factors associated with frailty, a concept implying a broader range of more subtle problems in multiple domains. This study conceptualized frailty as involving problems or difficulties in two or more functional domains (physical, nutritive, cognitive, and sensory) and analyzed prospective predictors. Subjects were 574 Alameda County Study respondents age 65–102. One-fourth scored as frail; there was no gender difference. Frail persons reported reduced activities, poorer mental health, and lower life satisfaction. Cumulative predictors over the previous three decades included heavy drinking, cigarette smoking, physical inactivity, depression, social isolation, fair or poor perceived health, prevalence of chronic symptoms, and prevalence of chronic conditions. By modifying these risk factors, it may be possible to postpone the onset of frailty or ameliorate its further development.*

THE term “frailty” appears with increasing frequency in the gerontological literature but there appears to be no consensus as to what the term actually means. In some cases frailty may simply denote a broad range of physical problems in old age or even aging itself. Examples include defining frailty in terms of a broad age range (FCA, 1978), as a continuum based upon a wide range of problems (Cox, 1993), or based upon the prevalence of any one of a number of conditions that are relatively common in old age (Winograd et al., 1991). With these definitions, the majority of older people would be considered frail.

Other researchers have defined frailty narrowly. Stamford (1972) used the term synonymously with institutionalization, while Manton, Stallard, and Liu (1993) applied it to the most severely impaired. Others focused on frailty as measured by disability, particularly difficulties in performing activities of daily living (American Medical Association, 1990; Guralnik and Simonsick, 1993; Solomon, 1988). By these measures only a small proportion of older persons would be considered frail and all of them would be disabled.

Both the broad and narrow definitions of frailty present problems with conceptual clarity and focus. If most older persons are characterized as frail, it would be better to simply talk about problems associated with aging. When frailty is narrowly associated with one outcome, such as institutionalization or disability, using the term for the particular outcome is more precise and hence more useful in problem description. Equating frailty with disability presents particular concerns because an older person might have difficulty walking yet be functioning well in all other physical activities. Finally, it is impossible to analyze risk factors for frailty when the term is used in so many different ways.

If the focus is shifted to what the definitions of frailty have in common, a possible solution emerges. Many studies of frailty have common underlying themes of vulnerability to environmental challenge based upon a complex or syndrome of underlying problems. Regardless of the specific definition, subjects are less capable than they previously were of dealing with a variety of problems imposed from the outside. Frailty can thus be conceived as a grouping of problems and losses of capability which make the individual more vulnerable to environmental challenge. Such a definition is consistent with its treatment in some medical texts (Fretwell, 1990) and with the models used to identify risk factors associated with muscle weakness and reduced function eventually resulting in falls (Fiatarone et al., 1994; Larson, 1991; Province et al., 1995). Vulnerability and syndrome imply an overall weakness to challenge that is manifested in a set of symptoms. These symptoms are typically evidenced in multiple areas or domains, such as physical, nutritive, cognitive, and sensory (Buchner & Wagner, 1992; Fried, 1992; Guralnik & Simonsick, 1993). A frail person would thus be someone who evidences deficiencies in more than one area or domain of functioning. In this way it is possible for disabled persons to be frail or not, depending upon whether the disability involves more than one area of functioning. The two concepts of frailty and disability may overlap at times, but they also indicate somewhat different underlying physical states.

The analyses reported here examine the predictors and prevalence of frailty in a community-dwelling sample of older persons. Frailty is defined as a syndrome involving deficiencies in two or more domains involving physical, nutritive, cognitive, and sensory capabilities. Prospective risk factors measured cumulatively over the previous 30

years are analyzed to suggest possible interventions to delay the onset of frailty. Finally, cross-sectional associations between frailty and other aspects of everyday life are examined to compare quality of life of frail older persons with those who are not frail.

## METHODS

### *The Alameda County Study*

Analyses are based upon data from the Alameda County Study, a longitudinal study of health and mortality that has followed a cohort of 6,928 persons originally selected in 1965 to represent the adult non-institutionalized population of Alameda County, California. Detailed design and sampling procedures for the baseline survey have been reported elsewhere (Berkman & Breslow, 1983). Subjects who move or become disabled are not dropped from the study. Survivors were interviewed in 1974, 1983 (50% sample), 1994, and 1995, allowing for analyses of prospective risk factors over three decades. Response rates for the five surveys have ranged from 85% to 97%.

### *Subjects*

Subjects eligible to be included in these analyses were those aged 65 and older who had been interviewed in all surveys through 1994. Of the 616 who were eligible, 42 were dropped because they had missing data on risk factors or on the 1994 frailty measures. The total utilized in the analyses was 574 of whom 247 were men and 327 were women. Mean age was 74.0 years (range 65 to 102). Women had a slightly higher mean age (74.2 years compared with 73.7 years for the men). Eighty percent of the sample had 12 years of education or more. Whites made up 82% of the sample, Blacks 10%, Asians 3%, Hispanics 3% and other groups 2%. Such small numbers precluded separate analyses by ethnicity; when used as a control variable ethnicity was coded dichotomously as Black, Asian, Hispanic, or other versus White.

### *1994 Frailty Measure*

Frailty in 1994 was assessed through 16 variables grouped to represent four functional domains. Four items assessed problems with physical functioning (sudden loss of balance, weakness in arms, weakness in legs, get dizzy or faint when stand up quickly); two assessed nutritive functioning (loss of appetite, unexplained weight loss); and four assessed cognitive functioning (difficulty paying attention, trouble finding the right word, difficulty remembering things, forgetting where put something.) The remaining six items assessed sensory problems: three assessed vision problems (difficulty reading a newspaper, recognizing a friend across the street, reading signs at night) and three assessed hearing problems (hearing over the phone, hearing a normal conversation, hearing a conversation in a noisy room). Scores for the six sensory items were 1 (have no difficulty), 2 (have a little difficulty), 3 (have some difficulty), and 4 (have a great deal of difficulty). Scores on the other ten items were 1 (rarely or never had the problem in the last 12 months), 2 (sometimes had the problem), 3 (often had the problem) and 4 (very often had the problem). Subjects

scoring a "3" or higher on at least one item in any domain were considered to have a problem or difficulty with that particular domain. Participants were classified as frail in 1994 if they reported having problems or experiencing difficulty in two or more domains. None of these measures had been asked in prior waves.

### *Risk Factors Evaluated in 1965, 1974, and 1983*

Patterns of risk factors across measurement points were based on the presence or absence of risk factors at each wave (1965, 1974, and 1983).

Health behaviors and psychosocial risk factors included alcohol consumption, obesity, smoking, physical inactivity, depression, and social isolation. Alcohol consumption classified subjects as abstainers, moderate drinkers (1–45 drinks per month) or heavy drinkers (over 45 drinks per month). Smoking was coded as current versus never/former smokers. The National Health and Nutrition Examination Survey II score classifications of 27.3 or more for women on the body-mass index (weight in kilograms divided by height in meters squared) and 27.8 or more for men were used to classify subjects as obese (Van Itallie, 1985). Physical inactivity was evaluated by four items asking subjects whether they often, sometimes, or never did physical exercises, took long walks, went swimming, or participated in active sports. Inactivity was defined as doing all four activities only sometimes or never compared with doing at least one activity often. Depression was evaluated by a score of five or more on the 18-item scale of depressive symptoms developed by Roberts and O'Keefe (1981). Social isolation classified subjects as isolated if they reported at least two of the following: fewer than three close friends, fewer than three close relatives, saw fewer than three friends or relatives in the past month. These factors have been found in previous Alameda County Studies to predict mortality, physical functioning, and successful aging (Berkman & Breslow, 1983; Kaplan et al., 1987; Kaplan et al., 1993; Kaplan et al., 1996; Seeman et al., 1987; Strawbridge et al., 1996).

Health status variables included perceived health, chronic conditions, and chronic symptoms. Perceived health classified subjects as fair or poor versus good or excellent in response to a question asking them to rate their own health. Chronic conditions included a count of self-reported prevalent heart trouble, hypertension, stroke, asthma, arthritis, diabetes, cancer, and bronchitis; classification was one or more versus none. Chronic symptoms included a count of self-reported chest pain, trouble breathing, swollen ankles, back pain, constant coughing or frequent chest colds, stiffness in joints, frequent leg cramps, and getting very tired in a short time; classification was two or more versus none. Similar classification of health status variables have been shown in recent analyses of older Alameda County Study subjects to prospectively predict poorer physical functioning, decline in physical function over six years, and lower likelihood of aging successfully (Camacho et al., 1993; Kaplan et al., 1993; Kaplan et al., 1991; Strawbridge et al., 1996).

### *1994 Quality of Life Measures*

Activities used to assess the quality of life for frail respondents compared to non-frail in 1994 included going out for

entertainment, visiting with family and friends, and frequency of attending religious services. Except for religious service attendance (which compared those attending at least weekly with those attending less or not at all), each item was dichotomized into "often" versus "sometimes" or "never."

Life satisfaction items included whether respondents enjoyed their free time, felt loved, and felt satisfied with relationships. These items were dichotomized as "very much" or "a lot" versus "some" or "not at all." Respondents were also asked whether they agreed or disagreed with the following statement: "When I look at the story of my life I am pleased at how things have turned out." Those agreeing were compared with those disagreeing.

Mental health was assessed with three variables. Respondents were asked to assess their own mental health; consistent with the scoring for perceived health, those rating their mental health as excellent or good were compared with those assessing it as fair or poor. Happiness was dichotomized as "very" or "pretty" versus "not too happy." Depression was assessed with the scale previously described under risk factors. Those not classified as depressed were compared with those classified as depressed.

#### Analysis Strategies

After calculating the proportion frail based upon reports of problems or difficulties in two or more domains, we examined the association of frailty with four demographic variables: age, gender, ethnicity, and education. Chi-square tests were used to test statistical significance of any observed association. We also calculated the proportion frail by gender for each of the four domains and for each of the individual measures.

To estimate the impact of cumulative predictors over 30 years on 1994 frailty we used logistic regression to compare the odds of being frail by the number of surveys (waves) in which subjects reported each of the risk factors in 1965, 1974, or 1983. Because of small numbers, subjects reporting the risk factor in two or three waves were combined. Indicator variables representing whether subjects reported each risk factor in zero, one, or two/three waves were used as independent variables so that the shape of the observed relationships could more readily be determined. Reporting the risk factor in zero waves was used as the comparison. In order to test for possible confounding effects of chronic conditions on any observed relationships between the other risk factors and frailty, two models were used: the first adjusted only for the four demographic variables (age, gender, ethnicity, and education) while the second added an adjustment for the number of waves (1965, 1974, or 1983) in which one or more chronic conditions were present.

To ascertain the impact of frailty on quality of life, we used cross-sectional logistic regression models with frail/not frail in 1994 as the independent variable. Dependent variables included often doing various activities, evidencing high life satisfaction, and having positive mental health. All models were adjusted for age, gender, ethnicity, and education.

All statistical analyses were performed with the use of SAS® software (SAS, 1993).

## RESULTS

### Proportion Frail

Of the total 574 subjects, 150 (26.1%) were classified as frail. Table 1 presents the proportion frail by the four demographic characteristics. The proportion frail increased sharply by age; there was only a prevalence of 18.3% frail in the 65–69 year age group compared with 48.8% frail for those 85 and older. Frailty was more prevalent among males than females by 28.3% to 24.5%, although this gender difference was not statistically significant ( $p < 0.21$ ). There was little difference in frailty by ethnicity. The prevalence of frailty was significantly lower among subjects with 12 years of education or more.

Table 2 presents the proportions by gender having problems or difficulty on each of the 16 items and for any item within each of the four domains. Higher proportions of males than females report problems or difficulties on the three hearing questions within the sensory domain and on all of the items within the cognitive domain. The individual variables where a higher proportion of females than males report problems or difficulties are mainly in the reading questions within the sensory domain and in the nutritive domain.

### Cumulative Predictors

Prospective cumulative predictors of frailty over 29 years are presented in Table 3. Frailty was assessed in 1994 while risk factors were assessed in 1965, 1974, and 1983. Results are included for the number of waves in which the indicated risk factor was present compared with not being present in any of the three waves. With adjustments for the four demographic variables, risk factors associated with subsequent frailty included heavy drinking, physical inactivity, depression, poor perceived health, having two or more chronic symptoms, and having one or more chronic conditions. Some of these associations were quite strong:

Table 1. 1994 Sample Distribution and Proportion Frail by Demographic Characteristics

Characteristic	Total <i>n</i>	Frail <i>n</i> (%)
Age**		
65–69	169	31 (18.3%)
70–74	175	38 (21.7%)
75–79	109	35 (32.1%)
80–84	80	26 (32.5%)
85+	41	20 (48.8%)
Gender		
Men	247	70 (28.3%)
Women	327	80 (24.5%)
Ethnicity		
Black, Asian, Hispanic, other	101	25 (24.8%)
White	473	125 (26.4%)
Education*		
Less than 12 years	115	40 (34.8%)
12 years or more	459	110 (24.0%)
Total Sample	574	150 (26.1%)

\* $p < .05$ ; \*\* $p < .01$ . Significance levels are based upon chi-square tests.

Table 2. Percent Having Problems or Difficulty by Gender for Domains and Items

Domain Frailty Variable	Percent Reporting Problem or Difficulty <sup>a</sup>		
	Males (n = 247)	Females (n = 327)	All (n = 574)
Physical Functioning	15.8	17.4	16.7
Sudden loss of balance	4.5	4.0	4.2
Weakness in arms	5.7	6.1	5.9
Weakness in legs	11.8	11.7	11.8
Dizziness when standing up quickly	2.8	4.3	3.7
Nutritive	3.6	5.8	4.9
Loss of appetite	2.9	3.1	3.0
Unexplained weight loss	2.0	4.3	3.3
Cognitive	28.3	23.6	25.6
Difficulty paying attention	6.9	3.4	4.9
Trouble finding the right word	12.6	10.2	11.2
Difficulty remembering things	16.3	13.8	14.9
Forgetting where put something	21.5	17.8	19.4
Sensory	47.8	45.3	46.4
Reading a newspaper	12.2	13.8	13.1
Recognizing friend across street	12.2	15.1	13.8
Reading signs at night	20.7	31.1	26.6
Hearing over the phone	23.5	7.7	14.5
Hearing a normal conversation	26.7	14.4	19.7
Hearing conversation in a noisy room	34.8	19.4	26.1

<sup>a</sup>Often or very often have problem for the first three domains. Have some or a great deal of difficulty for the sensory domain.

the risk for frailty was over three times greater for subjects depressed in two or three waves compared with those depressed in zero waves and the frailty risk associated with physical inactivity was twice as great for those inactive in two or three waves compared to none. The odds ratios for two or more chronic symptoms and one or more chronic conditions were also high. The odds ratios for abstaining from alcohol, cigarette smoking, and social isolation indicated an increased risk for frailty of about 50% to 70%; these associations were only marginally statistically significant. The additional adjustment for number of times in which respondents reported one or more chronic conditions made only minor reductions in the observed odds ratios from the first model.

Although caution is necessary because of small numbers in certain risk factor groups, the use of indicator variables in Table 3 allows visual inspection for dose response patterns. Changes in the magnitude of the odds ratios associated with the number of waves in which the risk factor was present provide some evidence whether the observed relationships are linear, exponential, or involve thresholds. For example, the odds of being frail increased roughly in a linear fashion for number of waves in which subjects reported being in only fair or poor perceived health, while the relationship between social isolation and frailty appeared to involve a threshold of two or three waves of exposure.

#### 1994 Quality of Life Assessment

Cross-sectional comparisons to assess the 1994 quality

of life of frail subjects compared with those who were not frail are shown in Table 4. The logistic regression analyses indicated that subjects who were not frail were more likely to go out for entertainment, and visit with family or friends. No statistically significant difference was found for attending religious services. Nonfrail subjects were also more likely to report feeling pleased about how their lives had turned out, enjoying their free time a lot, very much feeling loved, and being very satisfied with relationships. Those not frail reported better mental health and well-being on all three of the indicated measures.

#### DISCUSSION

##### Value of New Frailty Measure

We developed a new measure of frailty building on the two ideas that it should be conceived as a syndrome and as vulnerability to environmental challenge. To avoid narrowly equating frailty with disability or broadly describing the majority of older persons as frail, the measure used here assessed frailty as having problems or difficulties in two or more of four domains (physical functioning, nutritive, cognitive functioning, and sensory) and is thus consistent with the concept of frailty as a grouping of problems and losses of capability making the individual more vulnerable to environmental challenge. Although these domains have been suggested by others as important for assessing frailty, no one to our knowledge has attempted to combine them into a single measure. Our analyses showing that frailty seriously impacts quality of life for older persons demonstrates the value of this multi-domain approach as does the fact that many of the long-term predictors of frailty identified in our research are amenable to intervention.

##### Risk Factor Analyses

Our measure classified about one-fourth of Alameda County Study subjects age 65 or older as frail. The associations between frailty and age and education were not surprising, as these variables are typically associated with health outcomes in the same direction as here.

Using number of waves in which subjects reported exposure to risk factors over a 29-year period, we found that physical inactivity, depression, and fair or poor perceived health were strongly associated with subsequent frailty. Comparing the presence of risk factors in two or three waves with zero waves, the odds ratios for these three risk factors ranged from 2.10 to 4.60 adjusting for age, gender, race, and education. Our results for physical inactivity, depression, and perceived health are consistent with other studies that have identified these conditions as risk factors for both disability and change in physical functioning (Branch, 1985; Bruce et al., 1994; Ensrud et al., 1994; Kaplan et al., 1993; LaCroix et al., 1993; Pinsky et al., 1985).

The marginal association between abstinence from alcohol and subsequent frailty is supported by Ensrud et al. (1994) in an analysis of disability and may reflect the protective effects of moderate alcohol intake on coronary heart disease or persons abstaining because of poor health. This finding coupled with the association between heavy drinking at one wave and subsequent frailty fits the now familiar

Table 3. Cumulative Longitudinal Predictors over 29 Years of 1994 Frailty

Risk Factor	Total <i>n</i>	Model with age, gender, race, and education Odds Ratio <sup>a</sup>	Model with age, gender, race, education, and chronic conditions Odds Ratio <sup>a</sup>
<b>Obese</b>			
0 waves (reference)	412	1.00	1.00
1 wave	65	1.25	1.22
2–3 waves	97	1.36	1.22
<b>Alcohol Consumption</b>			
<b>Abstainer</b>			
0 waves (reference)	410	1.00	1.00
1 wave	70	1.71*	1.66*
2–3 waves	94	1.60	1.59
<b>Heavy Drinker</b>			
0 waves (reference)	424	1.00	1.00
1 wave	81	1.84**	1.97**
2–3 waves	69	1.42	1.39
<b>Cigarette Smoker</b>			
0 waves (reference)	332	1.00	1.00
1 wave	69	1.43	1.41
2–3 waves	173	1.48*	1.43
<b>Physically Inactive</b>			
0 waves (reference)	98	1.00	1.00
1 wave	121	2.04**	2.18**
2–3 waves	355	2.10**	1.95**
<b>Depressed</b>			
0 waves (reference)	444	1.00	1.00
1 wave	77	2.93***	2.76***
2–3 waves	53	3.58***	3.21***
<b>Socially Isolated</b>			
0 waves (reference)	383	1.00	1.00
1 wave	113	0.93	0.90
2–3 waves	78	1.66*	1.57
<b>Fair/Poor Perceived Health</b>			
0 waves (reference)	429	1.00	1.00
1 wave	78	1.95**	1.74**
2–3 waves	67	4.60***	4.08***
<b>2+ Chronic Symptoms</b>			
0 waves (reference)	261	1.00	1.00
1 wave	136	2.16***	1.97***
2–3 waves	177	2.92***	2.56***
<b>1+ Chronic Conditions</b>			
0 waves (reference)	167	1.00	NA
1 wave	182	1.69**	NA
2–3 waves	225	2.26***	NA

<sup>a</sup>Odds ratios compare likelihood of frailty for those reporting the indicated risk factor over 1 or 2–3 waves of the Alameda County Study compared with those not reporting the risk factor in any of the three waves.

\**p* < .10; \*\**p* < .05; \*\*\**p* < .01.

J-shaped curve theory for alcohol consumption and health outcomes (Hendrie et al., 1996; Poikolainen, 1995). That we found no comparable association for heavy drinking at two or three waves compared with zero waves may be because those drinking heavily did not survive long enough to remain in all waves of the study.

A similar argument can be made for cigarette smoking. The relatively small proportion of smokers surviving to old age could explain the inconsistent results found in studies

examining associations between smoking and physical functioning in old age (Camacho et al., 1993; Ensrud et al., 1994; Parker et al., 1996; Strawbridge et al., 1996). We found an elevated frailty risk of about 50% associated with prior cigarette smoking. In spite of differential mortality, our results imply that prior smoking may cast a long shadow impacting frailty in old age.

We also found an elevated risk of frailty for those who were socially isolated for more than one wave. Our social

Table 4. 1994 Quality of Life Assessment of Non-Frail Respondents Compared with Frail Respondents

1994 Characteristic	Non-Frail Compared with Frail <sup>a</sup> Odds Ratio
<b>Activities</b>	
Often go out for entertainment	2.41***
Often visit with family or friends	1.40*
Often attend religious services	1.23
<b>Life Satisfaction</b>	
Pleased how life turned out	2.22***
Enjoy free time a lot	2.09***
Very much feel loved	1.70**
Very satisfied with relationships	1.99***
<b>Mental Heal/Well-Being</b>	
Good or excellent mental health	3.97***
Very or pretty happy	4.27***
Not depressed	4.72***

<sup>a</sup>Odds ratios compare likelihood of reporting the characteristic for those classified as not-frail with those classified as frail. All models adjust for age, gender, race, and education.

\* $p < .10$ ; \*\* $p < .05$ ; \*\*\* $p < .01$ .

isolation measure assesses contacts with friends and relatives and is consistent with studies reporting that higher social participation predicts reduced morbidity, better physical functioning, and successful aging (Vogt et al., 1992; Kaplan et al., 1993; Seeman et al., 1987; Strawbridge et al., 1996).

Adjusting for chronic conditions made only modest reductions in the observed odds ratios even though it could be argued that this last adjustment is inappropriate for some risk factors where chronic conditions likely lie on the causal pathway to frailty.

#### Quality of Life Implications

Our cross-sectional analyses indicated that frailty is associated with a number of negative outcomes. Frail subjects were less likely than non-frail subjects to go out for entertainment or visit with family or friends. Their life satisfaction was lower and their mental health poorer. Frailty appears to take a substantial toll in activities, social relationships, and mental health.

#### No Gender Difference in Prevalence of Frailty

We did not find a higher prevalence of frailty among older women than among older men. Indeed, while not statistically significant, a higher proportion of males were scored as frail than females. Studies of disability in old age have consistently reported that community dwelling women have a higher prevalence of disability than men, (Aday, 1994; Fried et al., 1994; Jette & Branch, 1981, Leon & Lair, 1990; Manton, 1989; Rogers, Rogers, & Belanger, 1992; Strawbridge et al., 1992) so why is not the same true for frailty? Part of the reason is that disability is usually assessed in terms of mobility impairment or needing help on one or more basic activities of daily living, such as bathing or getting dressed. Our measures included assess-

ments of hearing and cognitive impairments and it was primarily within these two areas that the males in our study reported higher rates of problems or difficulties. Higher prevalence of hearing loss among older men than among older women has been documented both in the Alameda County Study and nationally (Wallhagen et al., 1997). Although the prevalence of dementia appears to be somewhat higher among older women than among older men (Breteler et al., 1992), the four measures we used assess problems at less serious levels of cognitive functioning than full-fledged dementia. It may be that older men have more cognitive problems at these levels.

The four physical functioning measures of sudden loss of balance, weakness in arms, weakness in legs, and dizziness when standing up quickly revealed no gender differences; the broader measures used in our scale may simply be a more sensitive measure of underlying physical, cognitive, and sensory problems than the activities of daily living or gross mobility measures used in many disability studies.

Another point to consider regarding gender differences in functioning among older persons is that the vast majority of older men are married while the majority of older women are widowed (Myers, 1990). Older men thus have more constant support available and so may be less aware of mobility impairment or problems with activities of daily living than older women who are much more likely to face these problems alone. Older couples often develop supportive strategies to cope with increasing deficiencies; widows have lost this resource. The four physical functioning measures we used may better reflect individual capabilities.

#### Possible Interventions

There is evidence that exercise programs can be effective in improving physical functioning even among the very old, although dropout rates from such programs are high (Fiatarone et al., 1994; Morey et al., 1991). Our results suggest that increased levels of physical activity might postpone the onset of frailty. Exercise in particular has been identified as protective for subsequent muscle weakness leading to falls (Fiatarone et al., 1994; Larson, 1991; Province et al., 1995). Perceived health appears to be strongly related to both pre-clinical and clinical disease (Kaplan et al., 1996); preventive strategies delaying the onset of disease ought to also delay the onset of frailty. A similar argument could be made for reducing depression, because there is evidence that the increased prevalence of depression in old age is partly a result of increased levels of disease (Roberts et al., 1997). Depression can also be treated by a variety of means including drugs and psychosocial interventions (Banerjee et al., 1996; Khan et al., 1993; Rothschild, 1996).

Alcoholism among the elderly is a recognized problem (Liberto, Oslin, & Ruskin, 1992); interventions include learning how to deal with stress in other ways than drinking and physical referrals to treatment programs (Council on Scientific Affairs, 1996).

Several Swedish studies have demonstrated improved well-being and physical functioning in older persons in different living situations who took part in structured social activities compared with similar persons not offered the

intervention (Andersson, 1984; Arnetz et al., 1983; Lökk et al., 1991). Increased social participation is also a likely side effect of many other interventions, such as development of senior centers, group exercise programs, volunteer service banks, group outings, one-on-one friendships, and retirement communities. Such programs may succeed in improving health outcomes partly because of the increased social participation that they generate.

An argument for health interventions in old age is that older persons already evidence higher rates of good health practices, such as not smoking, than younger persons and so may be more amenable to other interventions (Prohaska et al., 1985). Borgatta et al. (1990) argue that there are transition points in life when behavior changes are most likely to be made and that the point when personal health is most threatened may be one such point. Increasing frailty may serve as such a threat.

### Limitations

Limitations in the analyses presented here include a relatively small number of subjects, which precluded analyses by ethnicity and necessitated combining exposures for two and three waves. With a larger sample size it would be possible to compare more specific patterns of exposure; for example, in considering a risk factor such as social isolation, those with only one wave of exposure in the most recent wave (1983) might be different from those whose one wave of exposure was in the first wave (1965) but who have not been isolated since. Nine years between measurement periods is also a long time for accurate assessment of length of exposure. Finally, potentially strong factors such as serious falls and high alcohol consumption that might impact frailty and result in rapid deterioration could be missed by analyses involving long follow-ups where subjects must have survived and reported information over three decades. On the other hand, tracking risk factors for such a long time and then assessing their impact on a variable like frailty that is unlikely to have lasted as long, strengthens the argument that the causal link is from the risk factor to frailty rather than the other way around.

### Conclusion

We found that frailty was associated cross-sectionally with reduced day-to-day activities, feelings about social relationships, and mental health. Prospective analyses utilizing risk factor information collected over the previous three decades indicated that a number of risk factors amenable to intervention were associated with frailty. Behavioral and social interventions thus may be able to delay the onset of frailty and to ameliorate its progression once it begins so as to maintain quality of life among older persons.

### ACKNOWLEDGMENTS

This research was funded by a grant from the National Institute on Aging (1R37 AG-11375).

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Received August 28, 1996

Accepted June 26, 1997