Cognitive Impairment and Mortality in Older Community Residents

ABSTRACT

Objectives. Cognitive impairment among the elderly has been linked to mortality in studies of clinical populations. The purpose of this study was to examine the mortality risk associated with cognitive impairment among elderly populations in the community.

Methods. Cognitive impairment and other social and health factors were assessed in 1855 elderly community residents. This sample was reinterviewed periodically to assess changes in health and survival.

Results. At baseline 33% of the sample were mildly impaired and 8% were severely impaired. Across a 48-month observation period the survival probability was .85 for the cognitively unimpaired, .69 for the mildly impaired, and .51 for severely impaired respondents. When adjustments were made for the effects of other health and social covariates, severely impaired persons were twice as likely to die as unimpaired persons. Those who were mildly impaired were also at an increased risk.

Conclusions. Other investigators have found that cognitive impairment is a significant predictor of dementia. We found that it is a significant predictor of mortality as well. Early detection of impaired cognition and attention to associated health problems could improve the quality of life of these older adults and perhaps extend their survival. (*Am J Public Health.* 1994;84:1255–1260)

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Introduction

Deficits in cognitive functioning, prevalent among the elderly, are indicators of disease and disability.[1,2] Recent studies among noninstitutionalized populations, employing brief screening tests, indicate that 20% or more of the elderly population may be cognitively impaired. Three or four times as many persons have mild or moderate impairment.[3–5] There is a greater prevalence of cognitive impairment among the older old, those with less education, and minorities.[6–8]

Cognitive impairment is a threat to the quality of life of individuals and their families,[9,10] contributes to increased hospital use,[11,12] and is a risk factor for institutionalization.[13,14] The prevalence of shortened survival among those with dementing disorders[15,16] raises a question about whether milder forms of impairment are associated with mortality. The availability of brief yet reliable measures of cognitive performance[17,18] facilitates such studies.

Most studies linking mortality to cognitive impairment, however, are based on small numbers of elderly individuals with dementing disorders. These studies have employed various measures of cognitive impairment, including detailed clinical assessments. Survival rates have varied by severity of impairment, age, sex, and comorbidity.[19–24]

The few studies of elderly nondemented community residents differ in the representativeness of the samples, measures of cognitive impairment, length of follow-up, and whether other predictors of mortality were controlled.

Two longitudinal studies of nonrepresentative samples of elderly community residents, one of aged twins,[18] the other of very old persons,[25] yielded contrasting findings with regard to the linkage of mortality, impairment, and advancing age. No linkage was found in the study of twins. Increased mortality was associated with age in the study of very old persons later diagnosed as demented.

In a Scottish general practice population, a relative risk of early death of 3.5 was found for elderly cognitively impaired persons compared with nonimpaired persons, but there was no difference in risk of death between those with severe and moderate impairment.[26] These findings resemble those of Jorm et al. in an Australian community sample.[27] Neither study, however, employed multivariate analysis to control for potential risk factors other than age.

Shapiro and Tate recently estimated relative risks from Cox proportional hazards models for a subsample of participants in the Manitoba Longitudinal Study of Aging.[28] In addition to age and sex, cognitive impairment and a diagnosis of dementia contributed significantly to mortality. Potential risk factors including illness, income, and education were not studied, however, possibly because data

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TABLE 1—Selected Characteristics of the Study Sample (n = 1855)

Female, %	66.3
Age, %	
65–74 y	48.8
75–84 y	40.6
85+ y	10.7
Married, %	40.7
One-person household, %	43.8
Race other than White, %	5.0
Hispanic ethnicity, %	5.6
Employed full- or part-time, %	10.3
Mean annual income, $	12 039
Medicaid, %	14.6
Private health insurance, %	68.1

Note. Percentages, means, standard deviations, and all other calculations in this and subsequent tables are based on weighted data; totals are unweighted. Weights were applied to adjust for unequal probability sampling.

were limited to physician and hospital records.

Liu et al., studying a subsample from the Framingham Health Study,[29] related performance on a battery of neuropsychological tests to mortality over an 8- to 10-year period. Poor test performance was associated with an increased risk of death even after adjustment for age, education, and illness. The generalizability of these findings may be limited because of the study's high and selective nonparticipation rates. The validity of the test battery as a measure of cognitive impairment is also uncertain.

In this paper we report findings on the association between cognitive impairment and all-cause mortality in a large sample of urban elderly Medicare recipients.[30] Baseline measures of cognitive impairment were assessed as mortality risk factors by means of both univariate and multivariate statistical procedures, with adjustment for the effects of potentially confounding demographic, health, and social variables.

Methods

Sample

Data for this analysis are from personal interviews with 1855 community residents at least 65 years of age who were participants in a longitudinal study of aging and health (Norwood-Montefiore Aging Study [NMAS]).[31] The sample was randomly selected from a list of Medicare beneficiaries living in a neighborhood in the Bronx. Characteristics of the study sample are shown in Table 1. Two thirds were women, more than half were 75 years of age or older, 41% were married, and 44% lived alone. The mean annual income in 1984 was $12 039. Two thirds had private health insurance in addition to Medicare, and nearly 15% received Medicaid. The small proportions of non-Whites and Hispanics reflect the pattern of housing segregation in the study area.

Interviews conducted between July 1984 and March 1985 were the first in a series of semiannual contacts over 3½ years. The response rate to the baseline interview was 73%. Ninety-five percent or more of baseline respondents were reinterviewed in each successive interview wave. Dates and circumstances of death were obtained from proxies, usually family members. Respondents who discontinued participation were recontacted to ascertain survival status. Data were weighted to equalize the representation of elderly people living in households with more than one eligible person.

A 50% sample of nonrespondents was resurveyed 18 months after the health study was under way. Eighty-six percent of these persons, or their proxies, were recontacted. Compared with respondents, more nonrespondents assessed their health as poor or fair. They were more often women, were poorer, and were more likely to live alone. They were not older, however, and interviewers rated nearly equal proportions of both groups as "confused" (7.6% vs 6.6%).[32]

Measures

The Mini-Mental State Exam (MMSE), an instrument widely used to screen for cognitive impairment, was administered at baseline. Developed by Folstein et al., the MMSE assesses signs of dysfunction in orientation, registration, attention, calculation, recall, and language.[33] The MMSE was originally validated with hospitalized patients and subsequently adapted for use in the National Institute of Mental Health's Epidemiological Catchment Area Program.[34] It has been widely employed in studies in this country and abroad.[35–37]

MMSE scores range from 0 to 30. Persons with scores of less than 18 are defined as severely impaired, those with scores of 18 to 23 as mildly impaired, and those with scores of 24 and above as unimpaired. Although the MMSE is an easily administered and reliable tool to identify signs of cognitive impairment, scores do not provide clinical diagnoses.[38] Cognitive impairment may result from a variety of mental conditions including dementia, depression, brain injury, and mental retardation.[39]

Potentially significant mortality risk factors identified in the literature[40–42] were also measured at baseline. Demographic characteristics included age (measured in 5-year groups), sex, and race. Social characteristics included marital status, income (measured in $1000 increments), education (0–8 years vs more), living arrangement (alone or with others), whether any language in addition to English was spoken at home, and receipt of social support (both formal and informal vs neither or only one). Health characteristics included self-assessed health (fair/poor vs good/excellent), number of problems in activities of daily living, number of medical conditions, presence of two or more cardiovascular conditions, symptoms of depression (a Center for Epidemiologic Studies–Depression [CES–D] score less than 18), and visual or hearing problems.

Most of the items defining these variables were constructed from questions taken from the Aging Supplement of the National Health Interview Survey (NHIS) and the National Medical Care Expenditure Survey. Measures of social support and problems in daily living were modified to suit the character of the study sample. Social support was measured according to the frequency and amount of assistance received from family members (informal) or provided by agencies (formal) for personal care, shopping, traveling, money management, and the like, closely paralleling similar items employed by other researchers.[43] Problems in daily living (difficulties in carrying out daily activities) were similar to those used in other current research on functional performance.[44]

Analysis

The analytic strategy was survival analysis, employing Cox proportional hazards models in which the dependent variable, time to death, is predicted by the independent variables and by the MMSE score. This procedure uses all available information about study participants as long as they are followed and is therefore applicable when there are censored observations.

The validity of the proportional hazards assumption was assessed for each predictor by testing whether or not the hazard ratio changed with time. We found

no evidence of an increasing or decreasing trend in the hazard ratios.

Survival curves, by level of cognitive impairment at baseline, were constructed by means of a Kaplan-Meier product limit estimator and tested for homogeneity with the log rank test. The relationship between the independent variables and survival time was assessed with univariate Cox proportional hazards models. Statistically significant variables ($P < .05$) in the univariate analyses were incorporated as predictors in multivariate Cox regression models. Analyses were performed with the fast backward elimination procedure and with predictor variables entered simultaneously. Mortality risk factors for each cognitive impairment subgroup were identified by univariate and multivariate Cox regression analyses. Demographic, health, and social characteristics of the unimpaired and the two impaired subgroups were also compared. Differences among the groups were tested for significance with t tests (for continuous variables) or the chi-square test (for dichotomous variables).

TABLE 2—Baseline Characteristics of the Study Sample, by Level of Cognitive Impairment

	Level of Impairment			
	A Severe (n = 168)[a]	B Mild (n = 746)[a]	C No Impairment (n = 1340)[a]	Total Sample (n = 2254)[c]
Sociodemographic characteristics				
Mean age, y (SD)	80.5[C] (7.5)	76.4[C] (6.9)	73.8 (5.8)	75.4 (6.6)
Female, %	73[B]	66	65 (10 548)	66.3
Mean annual income $ (SD)	7179 (5477)	9763[A] (7648)	13 902[A,B] (10 458)	12 039 (9 512)
Education > 8 y, %	28	44[A]	71[A,B]	58.9
Married, %	25.7[B,C]	41.5[A]	42.2[A]	40.7
Non-White, %	8	7	3[A,B]	5.1
Receiving social support, %	27.4[B,C]	12.2[A,C]	7.7[A,B]	11.4
Living alone, %	54.8[B,C]	44.6[A]	42.0[A]	43.8
Language,[b] %	67.6[B,C]	50.1[A,C]	43.0[A,B]	47.6
Health characteristics				
Fair/poor self-assessed health, %	53[B,C]	42	40	41.3
Mean no. of problems in daily living[c]	2.0[B,C] (2.5)	0.9 (1.7)	0.5 (1.2)	0.7 (1.6)
Depressive symptoms, %	26[B,C]	15	13	14.4
Vision problems, %	41[C]	35	32	34.7
Hearing problems, %	46[C]	42[C]	34	37.8
Mean no. of medical conditions (SD)	2.4[B] (1.9)	2.1 (1.5)	2.3[B] (1.7)	2.2 (1.6)
Arthritis, %	58[B,C]	50	50	51.0
Stroke, %	8[C]	7[C]	4	5.1

Note. Table entries accompanied by capital letters in superscript are significantly greater than values for groups represented by the column letter at $P < .05$ by chi-square or t test.
[a]Weighted totals.
[b]Language other than English spoken at home in addition to English.
[c]Problems in performing daily activities.

Results

Characteristics of Cognitive Impairment Groups

At baseline, 41% of respondents scored as impaired: 33% scored in the mild range (MMSE scores 18–23) and 8% in the severely impaired category (MMSE scores <18). These rates, particularly for mild impairment, are higher than those found in the New Haven and Baltimore Epidemiological Catchment Area sites.[3,4] However, differences in scoring the MMSE (the Epidemiological Catchment Area scoring procedures modified Folstein's original scoring instructions), in the age distributions of the samples, and in administration of the MMSE may account in part for these different rates. The prevalence of impairment for men (39.2%) was not significantly different from that of women (42.1%). Advancing age was associated with severity of impairment.

Health and social characteristics of the unimpaired, mildly impaired, and severely impaired groups at baseline are shown in Table 2. Severely impaired persons compared with their unimpaired peers were older, had more health problems, were poorer, were not as well educated, and were more likely to be women.

Mildly impaired persons differed significantly from their unimpaired peers in age, income, and other socioeconomic characteristics, but not in level of education or in most measures of disability and health. Mildly impaired respondents were younger than their severely impaired peers, tended to be men, had higher levels of income and education, were more often married, less often lived alone, and reported fewer health problems.

Survival Probabilities

Sixteen percent of the sample died during a 4-year observation period. These persons represented 11% of the unimpaired, 20% of the mildly impaired, and 38% of the severely impaired persons.

Survival curves for impairment subgroups are shown in Figure 1. Probabilities of survival for severely impaired persons (.51), mildly impaired persons (.69), and unimpaired persons (.85) were all significantly different.

Predictors of Mortality (Time to Death)

The relationship between time to death and each baseline predictor variable, including severe and mild cognitive impairment, was assessed initially by means of a Cox univariate proportional hazards model. Results are shown in Table 3. Regression coefficients for nearly all demographic, social, and health variables were statistically significant. Except for income, each manifested a significant relative risk for shortened survival.

Statistically significant variables were next entered into a multivariate Cox regression model to assess the indepen-

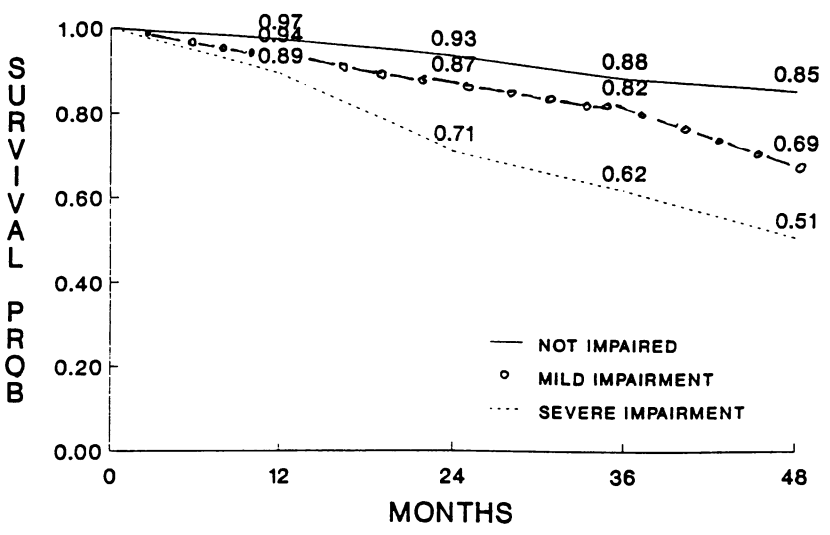

FIGURE 1—Survival curves and probabilities of survival, by level of cognitive impairment.

TABLE 3—Univariate Predictors of Mortality (Time to Death)

	Rate Ratio	95% CI
Age[a]	1.5	1.38, 1.62
Sex[b]	1.7	1.39, 2.13
Income	1.0	1.02, 1.06
Education[c]	1.6	1.27, 1.92
Problems in daily living	1.3	1.21, 1.32
Fair/poor self-assessed health	1.9	1.52, 2.29
Two or more cardiovascular conditions	1.7	1.27, 2.16
Depression	1.5	1.15, 1.91
Visual problem	1.3	1.02, 1.55
Hearing problem	1.5	1.26, 1.89
Receiving social support	2.9	2.26, 3.67
Married[d]	1.3	1.12, 1.56
Living alone	NS	. . .
Language	NS	. . .
Cognitive impairment		
Severe	4.2	3.10, 5.59
Mild	1.9	1.48, 2.33

Note. NS = not significant; CI = confidence interval.
[a]Categorized in sequential 5-year age groups (65–69, 70–74, etc., to 85+ years).
[b]Rate ratio calculated for males relative to females.
[c]Rate ratio calculated for those with less than 8 years of education relative to those with more education.
[d]Rate ratio calculated for those other than married relative to those married.

TABLE 4—Multivariate Predictors of Mortality: Total Sample (n = 1855)

	Rate Ratio	95% CI
Advancing age	1.3	1.16, 1.38
Low income	1.1	1.01, 1.05
Problems in daily activities	1.1	1.03, 1.19
Fair/poor self-assessed health	1.6	1.12, 1.84
Receiving social support	1.5	1.16, 1.99
Sex: male	1.1	1.18, 1.52
Severe impairment	2.2	1.13, 2.69
Mild impairment	1.5	1.12, 1.82
Education	NS	. . .
Married	NS	. . .
Depression	NS	. . .
Two or more cardiovascular conditions	NS	. . .

Note. NS = not significant; CI = confidence interval.

dent contribution of each variable, controlling for the effects of others. Results of the backward elimination procedure are shown in Table 4. The risk ratio was 2.2 for severe impairment and 1.5 for mild impairment. Thus, even when health, demographic, and social factors are controlled, cognitive impairment whether severe or mild, remains an important mortality risk. Other predictors were male sex, receipt of both formal and informal social support, fair or poor self-assessed health, two or more cardiovascular conditions, and advancing age.

Because men and women in this sample differed by marital status and other health and social characteristics, we entered interaction terms for sex and key independent variables in the multivariate models. However, high correlations between these variables and the interaction terms—for example, .59 (age), .76 (problems in daily living), .75 (self-assessed health), and .85 (social support)—precluded their inclusion in the model. We therefore developed multivariate models separately for men and for women. The results of the models, in which a backward elimination procedure was used, are shown in Table 5.

For both men and women, cognitive impairment is a significant risk factor; the risk is 2.0 for men and 2.3 for women for severe impairment. For mild impairment, the risk for both men and women was 1.5. Additional risk factors for men were poor self-assessed health, more problems in daily living, and low income. Additional risk factors for women were receipt of social support and more problems in daily living. Advancing age was a risk factor common to both.

Risk factors predicting mortality for the entire sample or for each sex, however, may differ by level of cognitive impairment, particularly given the differences in health and social characteristics and in mortality risk associated with different levels of impairment. To explore this issue, additional univariate and multivariate regression analyses were performed for each cognitive status subgroup (unimpaired, mildly impaired, and severely impaired). Results of the multivariate analyses, which employed backward elimination procedures, are shown in Table 6.

Advancing age is the only predictor common to all three groups. In addition to age, receipt of both formal and informal social support (a possible proxy for dependency) and only English spoken at home predicted shortened survival for severely impaired respondents. Absent in this subgroup are other health and social predicators.

Among the mildly impaired, less education, poorer health and functional status (more problems in daily living), receipt of both formal and informal support, advancing age, and male sex were risk factors. These same risk factors, except for social support, low education,

TABLE 5—Multivariate Predictors of Mortality, by Sex

	Rate Ratio	95% CI
Men (n = 631)		
Age	1.3	1.13, 1.42
Income	1.0	1.01, 1.05
Problems in daily activities	1.2	1.07, 1.27
Fair/poor self-assessed health	1.8	1.27, 2.43
Social support	NS	. . .
Education	NS	. . .
Depression	NS	. . .
Hearing	NS	. . .
Two or more cardiovascular conditions	NS	. . .
Severe impairment	2.0	1.13, 3.23
Mild impairment	1.5	1.07, 2.10
Women (n = 1223)		
Age	1.3	1.13, 1.45
Income	NS	. . .
Problems in daily activities	1.1	1.05, 1.21
Fair/poor self-assessed health	NS	. . .
Social support	1.8	1.22, 2.52
Education	NS	. . .
Married	NS	. . .
Race (Non-White)	NS	. . .
Depression	NS	. . .
Hearing	NS	. . .
Two or more cardiovascular conditions	NS	. . .
Severe impairment	2.3	1.52, 3.59
Mild impairment	1.5	1.07, 2.06

Note. NS = not significant; CI = confidence interval.

TABLE 6—Multivariate Predictors of Mortality, by Cognitive Impairment Status

	No Impairment		Mild/Moderate Impairment		Severe Impairment	
	RR	95% CI	RR	95% CI	RR	95% CI
Advancing age	1.4	1.20, 1.58	1.1	1.00, 1.29	1.3	1.04, 1.63
Sex: male	2.7	1.89, 3.72	2.6	1.81, 3.57	NS	. . .
Education	NS	. . .	1.6	1.15, 2.27	NS	. . .
Language	NS	. . .	NS	. . .	2.0	1.18, 3.27
Married	1.6	1.13, 2.33	NS	. . .	NS	. . .
Fair/poor self-assessed health	1.8	1.24, 2.47	1.6	1.12, 2.23	NS	. . .
Problems in daily activities	1.2	1.13, 1.34	1.1	1.04, 1.24	NS	. . .
Receiving social support	NS	. . .	1.9	1.24, 3.00	1.8	1.06, 3.12
Two or more cardiovascular conditions	NS	. . .	1.5	1.06, 2.18	NS	. . .

Note. RR = rate ratio; CI = confidence interval; NS = not significant.

and presence of two or more cardiovascular conditions, apply to the unimpaired subgroup.

Discussion

These results indicate that signs of cognitive impairment, both mild and severe, represent a significant threat to the survival of elderly community residents. In this sample, severely impaired persons were more than twice as likely as unimpaired persons to die within 4 years. Mildly impaired persons also had an increased risk for shortened survival, consistent with a recent finding from a Swedish sample.[35] Mortality risks were associated with severe and mild cognitive impairment even when adjustments were made for health and social factors, and the association was evident for men as well as women.

These findings, based on a large community sample, support the link between cognitive impairment and mortality found in the few studies of elderly persons without a diagnosis of dementia. These findings also point to the importance for shortened survival of mild cognitive impairment, a widely prevalent level of dysfunction among elderly persons in the community. Perhaps because there is often no obvious link to a known medical condition, mild impairment has not often been examined in studies of mortality, nor have physicians and others who provide health services to the elderly been encouraged to screen for its presence.[45]

Cognitive impairment may contribute to mortality in different ways for severely and mildly impaired individuals. Its progression may be a marker for the decline in health of those with dementing illness. Mild cognitive impairment may have a more indirect influence on mortality.[46] Deficiencies in language comprehension, in recall, or in other cognitive areas may contribute to failure to seek timely health care, to use recommended treatments or medications, or to recognize signs and symptoms of disease. If cognitive deficits limit educational and vocational achievement, the resulting socioeconomic disadvantage may then lead to poorer health and increased mortality.

Although this study was based on a large and randomly selected sample, the findings may be limited by the characteristics of the population. Compared with 1984 estimates of the US elderly population, the study sample was older, less affluent, and contained more women and more persons living alone. (Comparison data are available on request.) Data on mortality were based on proxy reports and not death certificates. However, information was obtained within 6 months of death, limiting the potential for recall error. Finally, cognitive impairment was measured by a screening instrument rather than a clinical assessment. Despite these potential limitations, the results are consistent with findings from the Manitoba and Framingham studies, even though the studies differ in samples and in measures of cognitive impairment.

Severe and mild impairment may be different conditions with different origins or different points along a continuum of cognitive decline. Although our data did not permit us to investigate this issue, some individuals with mild signs of cognitive dysfunction may have had a disadvantaged social status or poor health early on that may have limited the expression of cognitive capacity or even stunted its development. On the other hand, mild cognitive impairment may also herald the emergence of dementing illness among those who are not disadvantaged. Strategies designed to lessen the impact of cognitive impairment on the functioning of elderly people require diagnosis of the reasons for the impairment.

The prevalence of cognitive impairment among the elderly, particularly mild impairment, coupled with forecasts for increasing numbers of older persons into the next century, points to the need to train health care professionals to recognize this disability and deal with its potentially negative health consequences. □

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References

1. Kasper JD. Cognitive impairment among functionally limited elderly people in the community: future considerations for long-term care policy. *Milbank Q.* 1990;68:81–109.
2. Spector WD. Cognitive impairment and disruptive behavior among community-based elderly persons: implications for targeting long-term care. *Gerontologist.* 1991;31:51–59.
3. Holzer CE III, Tischler GL, Leaf PJ, Myers JK. An epidemiological assessment of cognitive impairment in a community population. In: Greenley JR, ed. *Research in Community and Mental Health.* Greenwich, Conn: JAI Press; 1984;4:3–32.
4. Folstein M, Anthony JC, Parhad I, Duffy B, Greenberg EM. The meaning of cognitive impairment in the elderly. *J Am Geriatr Soc.* 1985;33:228–235.
5. Escobar JI, Burman A, Karno M, Forsythe A, Landsverk J, Golding JM. Use of the Mini-Mental State Examination (MMSE) in a community population of mixed ethnicity. *J Nerv Ment Dis.* 1986;174:607–614.
6. Jorm AF, Scott R, Henderson AS, Kay DWK. Educational level differences on the Mini-Mental State Examination: the role of test bias. *Psychol Med.* 1988;18:727–731.
7. Fillenbaum G, Hughes DC, Heyman A, George LK, Blazer DG. Relationship of health and demographic characteristics to Mini-Mental State Examination score among community residents. *Psychol Med.* 1988;18:719–726.
8. Murden RA, McRae TD, Kaner S, Bucknam ME. Mini-Mental State Examination scores vary with education in blacks and whites. *J Am Geriatr Soc.* 1991;39:149–155.
9. Moritz DJ, Kasl SV, Berkman LF. The health impact of living with a cognitively impaired elderly spouse: depressive symptoms and social functioning. *J Gerontol.* 1989;44:S17–S21.
10. Deimling GT, Bass DM. Symptoms of mental impairment among elderly adults and their effects on family caregivers. *J Gerontol.* 1986;41:778–784.
11. Weiler PG, Lubben JE, Chi I. Cognitive impairment and hospital use. *Am J Public Health.* 1991;81:1153–1157.
12. Binder EF, Robin LN. Cognitive impairment and length of hospital stay in older persons. *J Am Geriatr Soc.* 1990;58:759–766.
13. Branch LG, Jette AM. A prospective study of long-term care institutionalization among the aged. *Am J Public Health.* 1982;72:1373–1379.
14. Kelman HR, Thomas C. Transitions between community and nursing home residence in an urban elderly population. *J Community Health.* 1990;15:105–122.
15. Jorm AF, Korten AE, Henderson AS. The prevalence of dementia: a quantitative integration of the literature. *Acta Psychiatr Scand.* 1987;76:465–479.
16. Evans DA, Funkenstein HH, Albert MS, et al. Prevalence of Alzheimer's disease in a community population of older persons. *JAMA.* 1989;262:2551–2556.
17. Kahn RL, Goldfarb AI, Pollack M. Brief objective measures for the determination of mental status in the aged. *Am J Psychiatry.* 1960;117:326–328.
18. Blum JE, Clark ET, Jarvick LF. The New York State Psychiatric Institute Study of Aging Twins. In: Jarvick JF, Eisdorfer C, Blum JE, eds. *Intellectual Functioning in Adults.* New York, NY: Springer; 1973:13–19.
19. Barclay LL, Zemcov A, Blass JP, Sansone V. Survival in Alzheimer's disease and vascular dementias. *Neurology.* 1985;35:834–840.
20. Heyman A, Wilkinson WE, Hurwitz BJ, et al. Early-onset Alzheimer's disease: clinical predictors of institutionalization and death. *Neurology.* 1987;37:980–984.
21. Walsh JS, Welch G, Larson EB. Survival of outpatients with Alzheimer type dementia. *Ann Intern Med.* 1991;21:363–370.
22. Burns A, Lewis G, Jacoby R, Levy R. Factors affecting survival in Alzheimer's disease. *Psychol Med.* 1991;21:363–370.
23. Kaszniak AW, Fox J, Gardell DL, Garron DC, Huckman MS, Ramsay RG. Predictors of mortality in presenile and senile dementia. *Ann Neurol.* 1978;3:246–252.
24. Van Dijk PTM, Dippel DWJ, Habbema JDF. Survival of patients with dementia. *Ann Geriatr Soc.* 1991;39:603–610.
25. Aronson MK, Ooi WL, Geva DL, Masur D, Blau A, Frishman W. Age-dependent incidence, prevalence and mortality in the old. *Arch Intern Med.* 1991;151:989–992.
26. Eagles JM, Beattie JAG, Rentall DB, Rawlinson F, Hagen S, Ashcroft GW. Relation between cognitive impairment and early death in the elderly. *BMJ.* 1990;300:239–240.
27. Jorm AF, Henderson AS, Kay DWK, Jacomb PA. Mortality in relation to dementia, depression and social integration in an elderly community sample. *Int J Geriatr Psychiatry.* 1991;6:5–11.
28. Shapiro E, Tate RB. The impact of a mental status score and a dementia diagnosis on mortality and institutionalization. *J Aging Health.* 1991;3:28–46.
29. Liu Y, Lacroix AZ, White LR, Kittner SJ, Wolf P. Cognitive impairment and mortality: a study of possible confounders. *Am J Epidemiol.* 1990;132:136–143.
30. Kelman HR. Commentary: Aging, health and health care. *J Community Health.* 1990;15:71–73.
31. Kelman HR, Thomas C. Hospital and ambulatory service use by the urban elderly under different health care delivery systems. *Med Care.* 1988;26:739–749.
32. Thomas C. The effect of nonresponse and attrition on samples of elderly people. Washington, DC: US Dept of Health and Human Services; 1989. DHHS publication PHS 3447.
33. Folstein MF, Folstein SE, McHugh PR. "Mini-Mental State": a practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res.* 1975;12:189–198.
34. Robins LN, Helzer E, Weissman MM, et al. Lifetime prevalence of specific psychiatric disorders in three sites. *Arch Gen Psychiatry.* 1984;41:149–958.
35. Johansson B, Zarit SH, Berg S. Changes in cognitive functioning in the oldest old. *J Gerontol.* 1992;47:P75–P80.
36. Park JH, Kwon YC. Modification of the Mini-Mental State Examination for use with the elderly in a non-western society, part 1: Development of Korean version of Mini Mental State Examination. *Int J Geriatr Psychiatry.* 1990;5:381–387.
37. Yu ESH, Liu WT, Levy P, et al. Cognitive impairment among elderly adults in Shanghai, China. *Gerontology.* 1989;3:S97–S107.
38. Tombaugh TN, McIntyre NJ. The Mini-Mental State Examination: a comprehensive review. *J Am Geriatr Soc.* 1992;60:922–935.
39. Anthony C, LeResche L, Niaz U, Von Korff MR, Folstein MF. Limits of the "Mini-Mental State" as a screening test for dementia and delirium among hospital patients. *Psychol Med.* 1982;12:397–408.
40. Manton KC. Changing concepts of morbidity and mortality in the elderly population. *Milbank Memorial Fund Q.* 1982;61:362–396.
41. Rice D, Feldman J. Living longer in the United States: demographic changes and health needs of the elderly. *Milbank Memorial Fund Q.* 1983;61:362–396.
42. Verbruqqe LM. Longer life but worsening health? Trends in health and mortality of middle aged and older persons. *Milbank Memorial Fund Q.* 1984;62:475–519.
43. Kelman HR, Thomas C, Tanaka JS. Longitudinal patterns of social support. *Soc Sci Med.* 1994;38:905–914.
44. Spector WD, Katz S, Murphy JB, Fulton JP. The hierachical relationship between activities of daily living and instrumental activities of daily living. *J Chronic Dis.* 1987;40:481–489.
45. Somerfield MR, Weisman CS, Ury W, Chase GA, Folstein MF. Physician practices in the diagnosis of dementing disorder. *J Am Geriatr Soc.* 1991;39:172–175.
46. Bassett SS, Folstein MF. Cognitive impairment and functional disability in the absence of psychiatric diagnosis. *Psychol Med.* 1991;21:77–84.