The Loss of Independence in Activities of Daily Living: The Role of Low Normal Cognitive Function in Elderly Nuns

ABSTRACT

Objectives. This study investigated the role of low normal cognitive function in the subsequent loss of independence in activities of daily living.

Methods. Of the 678 elderly nuns who completed cognitive and physical function assessments in 1992/93, 575 were reassessed in 1993/94. Mini-Mental State Examination scores were divided into three categories and related to loss of independence in six activities of daily living.

Results. Participants with low normal cognitive function at first assessment had twice the risk of losing independence in three activities of daily living by second assessment relative to those with high normal cognitive function. This relationship was largely due to a progression from low normal cognitive function at first assessment to impaired cognitive function at second assessment and was associated with an elevated risk of losing independence in the six activities.

Conclusions. Progression from low normal to impaired cognitive function was associated with loss of independence in activities of daily living. Thus, low normal cognitive function could be viewed as an early warning of impending cognitive impairment and loss of physical function. (*Am J Public Health.* 1996;86: 62–66)

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Introduction

Loss of independence in activities of daily living is a marker of decline and frailty in older adults and an indicator of health care use.[1–4] Loss of independence in activities of daily living refers to the inability to perform a function within the range considered to be normal for independent living.[5,6]

Decreased cognitive function is related to loss of independence in elderly people, particularly in the oldest old, where dementia is most prevalent.[1,4] Advanced age is also a predictor of future disability.[4–9] Some adults in older age groups, however, retain intact physical function.[10,11] Higher education is linked to better physical performance and lower risk of disability.[5,9,11–13]

Age and education have also been related to cognitive function and the risk of dementia in elderly people.[2,14–22] Cognitive function decreases with age, while the prevalence of dementia increases.[16,23] Yet low normal and high normal cognitive function are still prevalent in the oldest old.[24]

The current study investigated the role of low normal cognitive function at first assessment on the loss of independence in each of six activities of daily living at second assessment in a unique population of elderly women. Given that small declines in cognitive function within the normal range can be viewed as either "normal aging" or early progression toward dementia, it is important to determine whether such declines predict loss of independence in physical function. If so, screening and intervention strategies could be introduced in an earlier stage of cognitive decline.

In the present analysis, the relationship of cognitive function to loss of activities of daily living was investigated in elderly Catholic nuns (the Nun Study). This population is unique in that members live collectively in groups, assisted living communal settings, and nursing home facilities; eat from the same kitchens; receive comparable health care and preventive services; refrain from smoking; drink sparingly; and are nulliparous. Their vocation gives them access to similar social, financial, and spiritual supports as well. This relative consistency in their adult life-styles and environments minimizes the influence of many social, financial, biological, and behavioral variables that commonly confound other studies.

Methods

Study Population

The Nun Study is a longitudinal epidemiologic study of Alzheimer's disease and aging in US members of the School Sisters of Notre Dame religious congregation. Participating sisters were born before 1917 and recruited between 1991 and 1993. All participants agreed to (1) undergo annual assessments of cognitive and physical function, (2) allow investigators full access to their records, and (3) donate their brains at death for neuropathologic studies. A total of 678 (66%) of the 1027 eligible sisters participated in the study, a high rate of

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participation considering the brain donation requirement. Limited data available on the nonparticipating sisters included birth date, date of death, and country of birth. Participants did not differ from nonparticipants on mean age, percentage of annual mortality, or country of birth.

Data collection began with assessment of the participating sisters in 1991 through 1993. The second assessment was completed on the 575 surviving sisters during 1993/94. As a means of making the sisters as comparable as possible and minimizing the effects of other health conditions, only sisters who were independent in at least one activity of daily living at first assessment and survived to complete the second assessment were included in the analyses.

Activities of Daily Living

Performance on six activities of daily living (i.e., bathing, walking, dressing, standing from a seated to an erect position, toileting, and feeding) was determined during the first and second assessments. Walking, standing, dressing, and feeding were assessed in performance-based testing supplemented by nursing reports or self-reports (in those not using nursing services). Performance-based assessments were adapted from the Performance Test of Activities of Daily Living[25] and the Simulated Activities of Daily Living Examination.[26] Bathing and toileting were assessed by means of nursing or self-report (both reports involved multiple-choice questions from a modified version of the Blessed Dementia Scale[27]). Sisters were considered independent on a given activity of daily living if they required no human or mechanical (e.g., walker) assistance.

Cognitive Function

Cognitive function was assessed in a battery of neuropsychological tests,[28] including the Mini-Mental State Examination.[29] The Mini-Mental State Examination assesses orientation, memory, concentration, language, and praxis. Scores for this test were divided into quartiles based on their distribution in the 678 sisters at the first assessment. The first quartile, 0 to 23 (cognitively impaired), coincides with the generally accepted range indicating impairment.[30] The second quartile, 24 to 27 (low normal), is usually considered to be within the normal range. The third quartile, 28 and 29, and the fourth quartile, 30, were combined (high normal).

TABLE 1—Age- and Education-Adjusted Relative Risk (RR) of Loss of Independence in Activities of Daily Living in 530 Women, by Cognitive Function Category

Activity of Daily Living	Cognitive Function at 1st Assessment	No. at Risk for Loss of Independence	No. with Loss of Independence	RR of Loss of Independence from 1st to 2nd Assessment	95% Confidence Interval
Bathing	Impaired	12	5	2.43	0.87, 6.73
	Low normal	104	27	1.64	0.93, 2.86
	High normal	220	30	1.00	. . .
Dressing	Impaired	26	11	6.20	2.66, 14.46
	Low normal	131	24	2.39	1.23, 4.65
	High normal	242	16	1.00	. . .
Walking	Impaired	29	10	2.65	1.23, 5.71
	Low normal	100	28	2.10	1.21, 3.63
	High normal	205	28	1.00	. . .
Standing	Impaired	52	21	3.59	1.91, 6.73
	Low normal	135	29	1.68	0.97, 2.91
	High normal	239	26	1.00	. . .
Toileting	Impaired	45	19	8.61	4.06, 18.24
	Low normal	149	20	2.27	1.11, 4.62
	High normal	251	14	1.00	. . .
Feeding	Impaired	54	20	9.61	4.03, 22.94
	Low normal	157	17	2.18	0.98, 4.88
	High normal	248	11	1.00	. . .

Note. Mini-Mental State Examination score categories were as follows: high normal (28 to 30), low normal (24 to 27), and impaired (0 to 23).

Statistical Analyses

The relative risk of loss of independence in activities of daily living was calculated with Cox proportional hazards regressions.[31] This type of regression adjusts for differences in the length of observation between a first and second assessment. The length of observation for those who remained intact corresponded to the actual time between the first and second assessments, while the midpoint between these assessments was used for those who lost independence. Separate age- and education-adjusted regression analyses were conducted for each activity of daily living since the number of participants at risk for loss of independence differed for each activity.

Results

A total of 678 participants in the Nun Study, ranging in age from 75 to 102 years (mean = 83.3, SD = 5.47), completed the first assessment. Of these, 575 completed a second assessment (88 sisters died prior to completing a second assessment, 14 withdrew from the study, and 1 was outside the country). Of the 575, 530 were independent in at least one activity of daily living at the first assessment. Time between the first and second assessments ranged from 0.84 years to 2.80 years (mean = 1.7, SD = 0.23).

The number of people at risk and the number of incident cases of loss of independence for each activity of daily living are shown in Table 1. More than 80% of the sisters who were independent in a given activity of daily living at first assessment retained their independence in that activity at second assessment. For toileting and feeding, more than 88% retained independence.

Cognitive function, as indicated by Mini-Mental State Examination score, had a strong negative association with loss of independence in activities of daily living (Table 1). Sisters with impaired cognitive function had from 2.4 (bathing) to 9.6 (feeding) times the risk of losing specific activities of daily living relative to sisters with high normal cognitive function. There was also a stepwise increase in the risk of loss of independence across all activities of daily living as cognitive function declined.

Sisters with low normal cognitive function also had a significantly increased excess risk ($P < .05$) of losing independence in three of six activities of daily living and a suggestive increased excess risk ($P < .1$) in the other three activities.

TABLE 2—Age- and Education-Adjusted Relative Risk (RR) of Loss of Independence in Activities of Daily Living in 530 Women, by Change in Cognitive Function Category

Activity of Daily Living	Cognitive Function		No. at Risk for Loss of Independence	No. with Loss of Independence	RR of Loss of Independence from 1st to 2nd Assessment	95% Confidence Interval
	1st Assessment	2nd Assessment				
Bathing	High normal	Impaired	4	2	3.19	0.74, 13.69
	Impaired	Impaired	12	5	2.68	0.96, 7.50
	Low normal	Impaired	23	14	4.43	2.20, 8.93
	Low normal	Normal	81	13	1.09	0.55, 2.17
	High normal	Normal	216	28	1.00	. . .
Dressing	High normal	Impaired	5	3	10.29	2.81, 37.61
	Impaired	Impaired	26	11	7.91	3.27, 19.15
	Low normal	Impaired	31	12	6.91	2.93, 16.32
	Low normal	Normal	100	12	1.97	0.88, 4.44
	High normal	Normal	237	13	1.00	. . .
Walking	High normal	Impaired	4	1	1.94	0.26, 14.44
	Impaired	Impaired	29	10	2.70	1.25, 5.85
	Low normal	Impaired	25	12	3.74	1.83, 7.63
	Low normal	Normal	75	16	1.63	0.86, 3.09
	High normal	Normal	201	27	1.00	. . .
Standing	High normal	Impaired	6	3	5.25	1.55, 17.82
	Impaired	Impaired	52	21	4.02	2.11, 7.67
	Low normal	Impaired	31	11	2.91	1.38, 6.14
	Low normal	Normal	104	18	1.55	0.82, 2.92
	High normal	Normal	233	23	1.00	. . .
Toileting	High normal	Impaired	8	5	19.97	6.31, 63.20
	Impaired	Impaired	45	19	14.17	6.10, 32.88
	Low normal	Impaired	40	14	10.57	4.33, 25.79
	Low normal	Normal	109	6	1.46	0.51, 4.15
	High normal	Normal	243	9	1.00	. . .
Feeding	High normal	Impaired	7	7	128.39	34.30, 480.60
	Impaired	Impaired	54	20	31.46	9.76, 101.50
	Low normal	Impaired	42	12	17.97	5.43, 59.46
	Low normal	Normal	115	5	2.77	0.73, 10.57
	High normal	Normal	241	4	1.00	. . .

Note. Mini-Mental State Examination score categories were as follows: high normal (28 to 30), low normal (24 to 27), impaired (0 to 23), and normal (24 to 30).

However, the excess relative risk for those with low normal cognitive function at the first assessment was due to the subset of participants who progressed into impaired cognitive function by the second assessment (Table 2).

Discussion

In this study, Mini-Mental State Examination scores in the low normal range (24 to 27) were associated with an excess risk of loss of independence in activities of daily living. Much of this excess risk in those with low normal cognitive function appeared to be due to the subset of sisters who progressed into impaired cognitive function. Thus, low normal cognitive function could be viewed as a harbinger of impending cognitive impairment and subsequent loss of physical function. There are several possible scenarios that could explain this relationship.

One scenario is that the progressive decline from low normal to impaired cognitive function is due to dementing disease.[32] In this scenario, cognitive decline begins before first assessment, placing the individual in the low normal range at that assessment. Decline in cognitive function then continues through the second assessment point, where the person is cognitively impaired. This cognitive decline precedes the loss of independence in activities of daily living. Additional losses of independence in activities of daily living could be anticipated and perhaps prevented through the use of social support mechanisms and physical training.[33,34]

Another scenario is that there is concurrent decline in cognitive and physical function due to a cataclysmic or dramatically progressive event, such as stroke. Here, low normal cognitive function scores could reflect prior disease conditions, such as microinfarctions, transient ischemic attacks, or systemic vascular disease. Such diseases could predispose an individual to a subsequent stroke.

A third scenario is that the low normal cognitive level represents an expected range of cognitive performance within the general population. In this scenario, sisters in the low normal range achieved this level as their peak performance, or they declined gradually to this low normal level as a result of losses to normal aging. The decline from this low normal range to the impaired range is then secondary to an unanticipated occurrence (e.g., traumatic injury due to a fall), and the subsequent or concurrent physical decline may not be directly prevented. Given the relatively high achieved educa-

tion and physical function of the sisters in this analysis, this scenario is the least likely.

As an initial attempt to explore these scenarios, we examined data on 94 participants who came to postmortem evaluation. Of the 94, 15 had been assessed twice. Four sisters had Mini-Mental State Examination scores in the low normal cognitive function category at the first assessment and progressed into the impaired category at the second assessment. Three sisters had Alzheimer's disease (diagnosed at consensus conference by means of neuropathological and clinical data). The fourth sister had cerebral infarcts, but too few to indicate vascular dementia. While these numbers are small, there is an indication that, at least among the early deaths in our study, the first scenario might apply. That is, the decline from low normal to impaired cognitive function and the subsequent loss of activities of daily living are largely due to the progression of dementing disease.

Two caveats deserve mention. First, this population is not comparable to the elderly population in general. Our participants were highly educated, held intellectually stimulating occupations, had relatively healthy life-style practices, and had consistent and equal access to health services. Therefore, findings from the Nun Study may not be easy to generalize to other populations; rather, they may represent what is possible in a highly educated and relatively health conscious population. Second, because all participants agreed to brain donation, we can explore the relationship between Alzheimer's disease, stroke, and other neuropathologic causes of physical disability. However, we do not have data that will allow us to explore other causes of physical disability such as osteoarthritis and trauma.

The initial findings from this study suggest that low normal cognitive function (Mini-Mental State Examination scores of 24 to 27) may be a useful clinical indicator of older adults at increased risk for loss of independent physical function. People achieving low normal scores on the Mini-Mental State Examination should have their current physical function assessed. Secondary and tertiary preventive measures may be useful in maintaining current levels of physical independence and obviating the need for more expensive in-home or institutional supports.[34] Findings also point to the need for further research on the patterns of loss of physical and cognitive function related to specific diseases and environmental factors. □

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Certification Program for Public Health Pharmacy Begun by the Royal Society of Health

The Royal Society of Health, an interdisciplinary, international public health professional association, has announced a program for certification of public health pharmacy practice. The program was designed by pharmacists working for the US Public Health Service and peer-reviewed by other US public health pharmacists, prior to its approval by the Governing Council of the Royal Society of Health. The program is the first of its kind to recognize and certify pharmacists who are involved in public health pharmacy practice.

Modeled after existing certification programs in specialty pharmacy practice, this program will undertake to: (1) accurately describe the nature of demonstrated practice parameters within public health pharmacy; (2) reasonably establish the training, education, and experience of public health pharmacy; (3) elucidate the practice settings; and (4) establish a mechanism to attest to proficiency and capability.

The Royal Society of Health was established in 1876 and has steadfastly sought to improve the health of the public throughout the world. Its membership is composed of all professional disciplines involved in public health. Its more than 9000 members come from some 65 countries, with one of its largest national memberships in the United States.

The Society has long conducted examinations and provided certifications in public health areas such as nutrition, food hygiene, meat and poultry inspection, oral health education, and air pollution control.

The certification program will be managed by the US branch of the Society, with certificates being provided for successful applicants by the Royal Society of Health in London. Further materials and information on applying for certification in this program can be obtained by writing to the Public Health Pharmacy Certification Program, Royal Society of Health, PO Box 30100, Bethesda, MD 20824.