Cognitive Functional Status of Age-Confirmed Centenarians in a Population-Based Study

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The New England Centenarian Study is a population-based study of all centenarians in 8 towns near Boston, MA. Age was confirmed for 43 centenarians all alive on a designated date. To determine prevalence of dementia in centenarians, the authors analyzed neuropsychological, medical, and functional status data for 34 (79%) of the centenarians. Definition of dementia was based on the Consortium to Establish a Registry for Alzheimer’s Disease criteria, and a Clinical Dementia Rating (CDR) score was formulated for each participant. Seven (21%) had no dementia (CDR score 0), and an additional 4 (12%) were assigned a CDR score of 0.5, uncertain or deferred diagnosis. The remaining 22 (64%) had at least some degree of dementia. The authors calculated Barthel Index scores to determine ability to perform activities of daily living. There was a statistically significant correlation between CDR scores and Barthel Index scores (r = −0.73). Correlation was strongest for those with no or severe dementia, with the greatest range of function measured among those with moderate dementia.

The prevalence of dementia appears to increase dramatically from 1% at age 65 to 21–47% at ages 85 and older (Ebly, Parhad, Hogan, & Fung, 1994; Evans et al., 1999; Heeren, Lagaay, Hjimans, & Rooymans, 1991; Jorm, Korten, & Henderson, 1987; Rocca et al., 1990; Skoog, Nilsson, Palmertz, Andreasson, & Svanborg, 1993; Zhang et al., 1990), and the incidence of Alzheimer’s disease (AD) is 14 times higher among those aged 85 and older than among those aged between 65 and 69 (Hebert et al., 1995). Some researchers predict that everyone will have at least some degree of dementia by age 100 (Thomassen, Van Schaick, & Blansjaar, 1998). Others have stated that functional impairment is inevitable with aging (Olsansky, Carnes, & Cassel, 1993). Unfortunately, few studies have had enough nonagenarians or centenarians in their samples to make valid prevalence estimates for these age groups, and/or they did not differentiate between older age groups, combining those older than 85 years into one group. Exceptions are two studies conducted in Canada and Germany. In the Canadian Study of Health and Aging (CSHA), Ebly and colleagues (1994) examined 91 participants aged 95–99 years. In that study, although the prevalence was not statistically significant, the prevalence rose from 40% among Canadians aged 90–94 years to 59% among those aged 95–99 years. The Berlin Aging Study (BASE), a population-based study of participants aged 70–103 years, included 86 participants aged 95–103 years. Participants in the oldest age group had a 2.5 times higher risk for a less desirable psychological functional status than those aged 70–84 years (Smith & Baltes, 1997). However, relatively few participants were actually aged older than 100 years. In the same study, five parameters of cognitive function were negatively correlated with increasing age (Ulman & Baltes, 1997).

A report of the empirical findings of the Berlin Aging Study on the types and frequencies of psychiatric illness in old age noted an increase in the prevalence of moderate to severe dementia from 0% at age 70–74 to 32% at age 90–94. However, the increase was not exponential, leading the authors to suggest that “the exponential increase of dementia with age that has been extrapolated rather than established in the literature is true neither for women nor for men aged 95 and beyond” (Helmchen et al., 1999, p. 173).

Furthermore, some studies have indicated that the prevalence of dementia in centenarians is surprisingly low. A French study of 12 centenarians reported that only 3 were rated demented by DSM-III standards, and of the 3 only 1 met pathological criteria for AD (Hauw et al., 1986). Other studies have suggested that the incidence of dementia plateaus at extreme old age (Schoenberg, Kokmen, & Okazaki, 1987; Wernicke & Reischies, 1994). Ritchie and Kildea (1995), in a meta-analysis of nine epidemiological studies, found that the rate of increase in dementia prevalence fell off among octogenarians and plateaued at about 40% at age 95.

Of note is that there was no consistency in the methods employed to diagnose dementia. A number of studies used no neuropsychological testing, relying on a clinical interview or a retrospective review of chart notes. In others, one test or many tests were administered. Because centenarians until recently have been so rare, little testing of centenarians has been done, let alone in a manner that minimizes the risk of selection bias. Thus, neither standardized protocols nor population norms are available.

The plateauing of dementia incidence rates described by Ritchie and Kildea (1995) and Perls, Morris, Ooi, and Lipsitz (1993) might suggest the presence of demographic selection. Demographic selection, which has been well demonstrated in various animal models (Carey, Liedo, Orozco, & Vaupel, 1992), is the selecting out or persistence of hardy individuals with increasing age, while others succumb to disease or other environmental stressors. An example among humans is a genotypic correlate of AD, apolipoprotein E epsilon-4 (apo e-4). Individuals who are homozygous...
for apo ε-4 have a 2.3–8 times greater risk of developing AD compared with the general Caucasian population (Corder et al., 1993; Evans et al., 1997). The allelic frequency of apo ε-4 within this population drops off dramatically in the oldest age groups, presumably because of its association with AD (Corder et al., 1996; Rebeck et al., 1994). Accordingly, counter to popular predictions regarding the condition of the extreme old, we hypothesized that centenarians have escaped or at least markedly delayed diseases that cause earlier mortality among the vast majority of younger-old persons (Perls, 1995). Especially in the case of cross-sectional studies, one must be wary of cohort effects and selection bias (Smith & Baltes, 1997). Thus, to study the question of cognitive function of centenarians, we undertook a carefully constructed population-based study in New England. The inclusion of only the centenarians living on one specific date avoided the increased attrition effects observed in studies of the oldest old (Lindenberger et al., 1999). Lindenberger and colleagues in the Berlin Aging Study also raised the possibility of selection bias occurring because individuals with dementia are less likely to consent to participate. Helmchen and colleagues, also of the Berlin Study, observed dementia-related selectivity effects; however, they stated that “it remains unclear whether such selectivity can completely explain the flattening prevalence in very old age” (1999, p. 173).

METHODS

A population-based study was performed in which 86% of all centenarians living within an eight-town area were enrolled (n = 36). The lack of selection criteria beyond the population chosen allowed for a sample representative of the full range of cognitive functioning in centenarians living in the northeastern United States.

Participants

Participant ascertainment, recruitment, and age validation have been thoroughly detailed elsewhere (Perls, Bochen, Freeman, Alpert, & Silver, 1999). Massachusetts state law mandates that all towns conduct a local annual census. Most censuses are conducted by the local election offices, and a person’s right to vote depends on inclusion in the census. Thus, among older people, there is a high rate of inclusion. Nursing home administrators are required to submit complete lists of all residents without regard to the person’s ability to vote. Census data include birth date and address. We found the census lists for the towns included in our study to be 100% sensitive and approximately 50% specific. Nearly all of the decreased specificity was due to listed centenarians who had died. Other surveillance sources included local agencies and councils on aging, newspapers, and physicians.

To determine the prevalence of dementia among the centenarians in the eight-town area, we prospectively chose a specific “slice in time”: December 31, 1996. On that day, we contacted 43 age-validated centenarians and/or their families to verify that they were alive (a centenarian prevalence of approximately 1 per 10,000). Of these 43 living centenarians (or their legal proxies), 7 (16%) refused to be in the study (although family members gave us enough information to validate ages of these potential participants). Those who refused did not statistically differ from those enrolled in terms of residence type, whether or not they were bedridden, race, and socioeconomic status.

The 36 age-confirmed centenarians ranged in age from 100 to 107. Thirty-one (85%) were women, and 5 (15%) were men. Three (9%) participants lived alone, 8 (21%) lived with family, and 25 (70%) lived in nursing homes. Eighteen (50%) of the participants were foreign born. The most frequent birthplaces were Italy, Ireland, and Canada. There was a wide range of education from 1 to 20 years (M = 11 years); 2 participants, a man and a woman, had doctorate degrees.

We performed detailed neuropsychological tests on 34 participants. The two remaining enrolled participants (women) died before testing could be performed. By history, they were likely to have had at least mild cognitive impairment, although the etiology was unknown.

Neuropsychological Measures

All participants underwent an extensive neuropsychological test battery (Table 1). In planning a neuropsychological test battery for centenarians, the first consideration was that tests with normative data for a population aged 100 years and older were not available (Ritchie, 1995). Although in recent years normative data have been available for older groups, these norms have usually not extended beyond the age of 89 years; the number of nonagenarians in the normative samples has been very small (Ivnik et al., 1992; Malec et al., 1992). Therefore, widely accepted tests for older participants were adapted for the centenarians.

The Mattis Dementia Rating Scale (MDRS; Mattis, 1988) was selected because it is a widely used and well-accepted instrument for assessment for the presence of dementia in a geriatric population and provided a baseline to track decline over time. The MDRS also has the advantage of assessing multiple domains of cognition: Attention, Initiation/Perseveration, Construction, Conceptualization, and Memory. These domains can then be compared for their relative contribution to the participant’s neuropsychological presentation and used to help distinguish between various forms of dementia. Because the MDRS did not include all the cognitive domains that we considered important to assess, a number of additional tests were added. To assess language function (specifically confrontation naming, which is often impaired in AD), we chose the Boston Naming Test. We

<table>
<thead>
<tr>
<th>Table 1. Neuropsychological Test Battery</th>
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<tbody>
<tr>
<td>Mini-Mental State Examination</td>
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<tr>
<td>Mattis Dementia Rating Scale</td>
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<tr>
<td>Boston Naming Test (CERAD)</td>
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<tr>
<td>Trail-Making Test A &amp; B</td>
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<tr>
<td>Clock Drawing</td>
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<tr>
<td>Drilled Word Span Test</td>
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<tr>
<td>Cowboy Story</td>
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<tr>
<td>(Boston-Rochester Test)</td>
</tr>
<tr>
<td>Presidents since</td>
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<tr>
<td>Franklin Delano Roosevelt</td>
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<tr>
<td>Spiers’ Calculations</td>
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<td>Geriatric Depression Scale</td>
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<tr>
<td>Telephone Interview for Cognitive Status</td>
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<tr>
<td>Test for Severe Impairment</td>
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<tr>
<td>Tactile Naming</td>
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<tr>
<td>Cognition and Health History</td>
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<tr>
<td>(Informant)</td>
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<tr>
<td>Psychiatry History (Informant)</td>
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<tr>
<td>Clinical Dementia Rating Scale</td>
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<tr>
<td>NEO-Five Factor Inventory: Self-report</td>
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<td>and observer report</td>
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used a 15-item version developed by the Consortium to Establish a Registry for Alzheimer’s Disease (CERAD; Mack, Freed, Williams, & Henderson, 1992), which correlated well with the original 60-item version (Kaplan, Goodglass, & Weintraub, 1983). Missing data were considered in the context of other overlapping tests for which data were available. If data were missing because of sensory impairment, we used other sensory-impairment-friendly tests to gather such data. For example, if visual impairment was severe enough that the participant could not see the Boston Naming Test stimuli, he or she was presented with 10 objects to feel (e.g., a cup, keys, eyeglasses, a toothbrush).

The Mini-Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975) was included in the battery because it is so often used in geriatric dementia studies. For this reason, we decided that it would give us the opportunity for comparison with other studies. Additionally, we believed that it was useful as a baseline for later follow up, particularly if participants’ health status had declined and they could not tolerate prolonged testing. We included the Trail-Making Test (Army Individual Test Battery, 1944) to measure sustained attention, sequencing, and cognitive flexibility (ability to shift set). We used the Drilled Word Span Test (Weintraub & Mesulam, 1985) to assess new learning with drill and repetition and to measure rate of forgetting, important diagnostic information for AD. In this test, the length of the word list administered was one less than the participant’s attention span. This shorter, adjustable word list made it a more feasible test for centenarians than commonly used tests such as the California Verbal Learning test, which has a 16-item word list (Delis, Kramer, Kaplan, & Over, 1987).

The Cowboy Story from the Boston Rochester Test (Kaplan, Caine, & Morse, 1983) tested delayed memory and how well logically related material was recalled. As a test of long-term memory for information, participants were asked to name all the presidents since Franklin Delano Roosevelt. An arithmetic test, Spiers’ Calculations, was also administered (Spiers, 1986).

For the visually impaired, the Telephone Interview for Cognitive Status (Brandt, Spencer, & Folstein, 1988), which is entirely verbal, was included. The Test for Severe Impairment (Albert & Cohen, 1992) was administered to those with scores of 10 or less on the MMSE. We intended this test to provide a baseline to follow for further cognitive decline.

We used the Geriatric Depression Scale (GDS; Yesavage et al., 1983), to rule out depression as a possible factor in cognitive impairment. The GDS was developed for older patients and omits questions about vegetative signs, such as sleep disturbance and appetite, which may indicate depression in younger but not necessarily older people.

Detailed cognitive and psychiatric history forms were completed with information gathered from family members and/or nursing home records. The Multiple Data Set (MDS), a quarterly update of cognitive and behavioral status that is required in nursing home charts, was an important source of data.

We included the Hachinski scale (Hachinski et al., 1975; Hachinski, Lassen, & Marshall, 1974) for calculation of an ischemic score to evaluate risk of vascular dementia. This scale has items regarding medical and psychiatric symptoms as well as history of symptom progression.

Special Modifications

All testing was done in the centenarian’s home or long-term care facility, because transporting centenarians to an office was not feasible and was an undue hardship for them. Because many—but certainly not all—of the centenarians tended to tire more easily than a younger population, tests were administered in from one to four sessions. If a centenarian began to tire, testing was stopped and an appointment was made to continue another day. Typical of the variability in this extreme old population, some centenarians could tolerate only 20 min of testing, whereas others could complete a 2–3-h battery in one session. In sessions in the home, testing was most often done at the kitchen table with family members present. There were usually family members present when the testing was performed in a long-term care facility.

Slowed motor speed was anticipated in this very old population and was not considered to be a marker of dementia. For this reason, tests with a motor component, such as the Trail-Making Test, were not timed.

Approximately 45% of the participants had vision and/or hearing impairment sufficient to interfere with standard administration of tests. We enlarged test stimuli to accommodate visually impaired participants. For example, the MDRS stimuli, the Boston Naming Test pictures, and the written command and the intersecting pentagons on the MMSE were all enlarged. A greatly enlarged version of the Trail-Making Test was created: 1 participant who was legally blind (with no vision in his right eye and a right field cut in his left eye) was able to complete Trails A and B, using the enlarged test. It took him 8 min because scanning the page was very difficult.

A small amplifier with earphones was taken to all testing sessions for those with hearing impairment. Family members were usually present for the testing and helped hearing-impaired participants understand particular words or questions, because the participants were familiar with their intonations and vocabulary. Large-type visual backups were used when the amplifier was not adequate. For instance, the Conceptualization questions on the MDRS (i.e., similarities) were presented in printed form at the same time they were asked verbally. Instructions, usually presented orally, were available in printed form. At times, printed modifications changed the nature of the test; for example, the MMSE recall section of three words read by the examiner was no longer a purely auditory recall test. We decided, however, that the information gained was worth the modification.

In addition to helping with hearing problems, family members served as translators for participants with limited English. They repeated questions and verified that responses in a foreign language were correct; for example, names of items in the Boston Naming Test. The fact that English was a second language for some participants was also taken into consideration in interpreting certain scores, particularly Conceptualization scores, because scores in this cognitive domain are thought to be negatively affected when English is not the first language (Albert, 1988).
Centenarians are a population in which diagnosis of cognitive status must take into consideration multiple factors—medical illness, medications, psychosocial issues, psychiatric conditions, and so on. This group has had an enormous number of extremely varied life experiences that have affected their cognitive development. Given these factors and the absence of norms, Mattis (1997) argued that a clinical diagnosis may be the best—and perhaps only—way of evaluating extremely old persons.

### Diagnostic Criteria for Diagnosis of Dementia

A Clinical Dementia Rating (CDR) score based on criteria established by CERAD (Morris et al., 1989) was calculated. The CERAD protocol requires the evaluation of six categories to determine a CDR staging: memory, orientation, judgment and problem solving, community affairs, home and hobbies, and personal care. Impairment in these categories is rated according to a 5-stage scale: none (0), questionable (0.5), mild (1), moderate (2), severe (3), profound (4), and terminal (5). Examiners use a formula to calculate an overall score. This score is not an average of the categories; for example, if at least three other categories are given the same score as memory, then the CDR score corresponds to the memory score (for details of scoring, see Berg, 1988). The final score is assigned a dementia rating: 0 (no dementia), 0.5 (uncertain or deferred diagnosis), 1 (mild dementia), 2 (moderate dementia), 3 (severe dementia), 4 (profound dementia), or 5 (terminal dementia).

Calculation of the CDR score was based on daily functioning, as well as neuropsychological testing. Data came not only from the testing data but from interviews with participants and their families; medical, cognitive, behavioral, and psychosocial records; and clinical observations. In cases where the full test battery could not be completed, histories, interviews, and functional status usually supplied enough data for us to make a diagnosis; for example, for those with very severe deficits in both vision and hearing and those who could not perform writing and drawing tests because of arthritis or stroke. If a diagnosis was still questionable, uncertain diagnosis was assigned. These multiple sources of data enabled us to evaluate the full range of functioning in centenarians, including those with severe dementia with whom testing was limited and those with profound and terminal dementia who could not engage in formal testing at all. The entire data collection for each individual participant was administered and analyzed, and the diagnosis was assigned by the neuropsychologist. The diagnostic process was that used in a clinical setting—we compiled psychometric data, history, and observation and integrated these data through clinical judgment to formulate a diagnosis. As in the criteria in the fourth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV; American Psychiatric Association, 1994) for dementia, daily functioning was an essential part of the diagnosis. Results of individual tests were not analyzed separately for the study group as a whole, because in isolation without supporting data (and given cases of limited testing and various modifications) they would be difficult to interpret. For example, prevalence of depression could not be determined when more than a third of the participants could not respond to questions on the GDS.

### Results

#### Prevalence of Dementia

Of the 34 participants, 7 (21%) had a CDR score of 0, no dementia. Four (12%) were assigned a CDR score of 0.5, uncertain or deferred diagnosis. Three (9%) were given a CDR score of 1, mild dementia. Ten (28%) had a CDR score of 2 (moderate dementia), and 7 (21%) had a CDR score of 3, severe dementia. One (3%) had a CDR score of 4, profound dementia. Two (6%) had a CDR score of 5, terminal dementia (Table 2).

#### Correlating Degree of Dementia With Activities of Daily Living (ADL) Abilities

We rated physical functional status using the Barthel Activities of Daily Living Index (Mahoney & Barthel, 1965; Sinoff & Ore, 1997). The Barthel Index, which is rated on a scale of 0, 5, or 10 (dependent, needs assistance, or independent, respectively), includes the following times: feeding, bathing, grooming, dressing, bowel and bladder control, toileting, bed-to-chair transfers, ambulation, and stair climbing. Participants scoring between 80 and 100 are regarded as independent, and those with scores between 60 and 79 need minimal help in ADLs. Scores between 40 and 59 indicate partial dependence. Those with scores between 20 and 39 are very dependent, and scores less than 20 represent total dependence.

The range of Barthel Index scores for 33 centenarians was 0–100. (We were unable to rate 1 participant because she died before accurate rating could be performed.) Nine (27%) participants were independent (score 80–100) with range of CDR scores from 0 (no dementia) to 2 (moderate dementia; see Table 3). Eight (23%) participants required minimal assistance (score 60–70) with a range of CDR scores from 0 (no dementia) to 2 (moderate dementia). Another 8 participants (23%) were in the partial dependence category (scores 60–79) with a range of CDR scores from 0.5 (questionable dementia) to 3 (severe dementia). Five participants (15%) were significantly dependent (score 20–39) with a range of CDR scores from 1 (mild dementia) to 5 (terminal dementia). Six totally dependent subjects (18%) had a range of CDR scores from 3 (severe dementia) to 5 (terminal dementia).

There was a statistically significant correlation between CDR scores and Barthel Index scores ($r = -0.73$). For the highest functioning ($CDR = 0$) and lowest functioning ($CDR > 4$) centenarians, the range of Barthel Index scores was relatively small (80–100 and < 20, respectively). In the

### Table 2. Summary of Results of Neuropsychological Examinations

<table>
<thead>
<tr>
<th>CDR Score</th>
<th>Description</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No dementia</td>
<td>7 (21%)</td>
</tr>
<tr>
<td>0.5</td>
<td>Uncertain or deferred diagnosis</td>
<td>4 (12%)</td>
</tr>
<tr>
<td>1</td>
<td>Mild dementia</td>
<td>3 (9%)</td>
</tr>
<tr>
<td>2</td>
<td>Moderate dementia</td>
<td>10 (28%)</td>
</tr>
<tr>
<td>3</td>
<td>Severe dementia</td>
<td>7 (21%)</td>
</tr>
<tr>
<td>4</td>
<td>Profound dementia</td>
<td>1 (3%)</td>
</tr>
<tr>
<td>5</td>
<td>Terminal dementia</td>
<td>2 (6%)</td>
</tr>
</tbody>
</table>

*Note: CDR = Clinical Dementia Rating.*
middle categories, however, there was a wider range. For example, participants with moderate dementia (CDR = 2) had Barthel Index scores ranging from 85 to 25. The score at the upper extreme of 85 represented a 100-year-old man in excellent health, who lived with his son and daughter-in-law in a home where he had lived for more than 40 years. He ambulated independently and had no sight or hearing impairment. Medical diagnoses included angina and adult onset diabetes. The nature of his mild health problems and his familiar environment with a well-learned routine, which did not place demands on compromised cognitive functions, like memory or learning new information, may have enabled him to function quite well on a daily basis with moderate cognitive deficits.

**Table 3. Cross-Tabular Correlations Between Barthel Index Scores (Functional Status) and CDR Scores**

<table>
<thead>
<tr>
<th>CDR Score</th>
<th>Independent (80–100; n = 9)</th>
<th>Minimal Help (60–79; n = 7)</th>
<th>Partially Dependent (40–59; n = 6)</th>
<th>Very Dependent (20–39; n = 4)</th>
<th>Totally Dependent (&lt;20; n = 7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No dementia (0; n = 7)</td>
<td>5</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Uncertain dementia (0.5; n = 4)</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mild dementia (1; n = 3)</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Moderate dementia (2; n = 10)</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Severe dementia (3; n = 7)</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Profound dementia (4; n = 1)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Terminal dementia (5; n = 2)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>

*Note: CDR = Clinical Dementia Rating.*

**Discussion**

In this study we ventured into uncharted waters to study centenarians, a group for which there are no normative data and few guidelines. Furthermore, this is a cohort where evaluation is often complicated by sensory impairment and medical illness. Given these difficulties and complexities, we used a clinical methodology to evaluate these participants and formulate a CDR score, because this approach enabled us to take into consideration the multiple factors that influence cognition in this group. It also provided backup information for test data missing because of participants’ sensory or other limitations. Even a creator of a carefully normed geriatric assessment instrument has called a clinical diagnosis perhaps the best way for researchers to evaluate extremely old persons (Mattis, 1997). Great care was taken in choosing tests that were suitable for this population and did not place uncomfortable demands on these extremely old participants.

In this population-based group of age-confirmed centenarians, 21% were not demented according to CDR scores. An additional 4 (12%) were assigned a CDR score of 0.5, uncertain or deferred diagnosis, and therefore some or all of these participants could possibly have had a reversible process explaining their cognitive impairment. Thus, the prevalence range of dementia in this centenarian sample was 67–79%. Sixteen percent of the centenarians in the population refused to participate. It is possible that a disproportionate number of refusals were made on the basis of poor functional status and a desire to not bother these potential participants. However, we were able to obtain enough information from these participants and their families to determine that they were not statistically different from enrollees in terms of socioeconomic status, race, gender, and bedridden status. Thus, these findings counter the supposition made by some that dementia is a universal finding among centenarians (Thomassen et al., 1998).

Barthel Index scores indicated that there was a correlation between level of cognitive functioning and ADLs in the centenarians. Not surprisingly, correlation was strongest in the highest (CDR = 0) and lowest (CDR = 5) dementia categories. However a notable range of Barthel Index scores was noted in the moderate dementia category (CDR = 2), where sensory impairment and medical illnesses that limit mobility have a greater impact than they would on those with no cognitive deficits. In this moderately impaired group, an environment that supports maximum potential functioning and does not contribute to excess disability may have a significant impact on level of functioning. A few participants still functioned remarkably well despite the finding of moderate dementia (CDR = 2); for example, the male participant previously mentioned and a moderately demented woman who functioned independently in an apartment she had inhabited for many years. In these instances, a familiar environment and routines may make few demands on planning abilities, new learning, or memory, so that an individual can continue to function relatively well. In other instances, some increased level of adaptive capacity and/or functional reserve might explain these paradoxes, as was proposed in a case of a 102-year-old participant presumed to be cognitively normal who was found to have significant neuropathological findings supportive of a diagnosis of AD (Snowdon, 1997).

We identified 7 participants as clinically free of dementia at age 100 or older. Two of these participants, who subsequently died, also went on to neuropathological study. As reported in detail elsewhere, they had no neuropathological evidence of dementia by Braak and Braak staging and CERAD criteria with a near absence of neuritic plaques, neurofibrillary tangles, and pathological vascular changes (Silver et al., 1998). At least in these two cases, there was no subclinical dementia. Since that time, 4 additional participants with no dementia on testing have been found to have no pathological markers for AD and other dementias. Thus, neuropathological studies have confirmed diagnosis in the participants with no dementia. Another study, by Mizutani
and Shimada (1992), also noted several centenarian cases without neuropathological demonstration of neurofibrillary tangles or ischemic changes. Participants such as these represent the neuropsychological and neuropathological gold standard of disease-free aging.

Although 67–79% of centenarians have some degree of dementia, we have preliminary data from a retrospective review suggesting that nearly all the centenarians in our sample were cognitively and physically independent at age 90 and the majority were still so at age 95. Thus, we believe that relative to the general population, centenarians represent a cohort of individuals that either markedly delay or escape dementing illnesses such as AD and cerebrovascular disease.

A relative resistance to diseases associated with significant mortality, such as AD, could explain the plateauing of dementia prevalence in extremely old persons that has been proposed by numerous investigators (Perls, 1995; Ritchie & Kildae, 1995; Schoenberg et al., 1987; Wernicke & Reischies, 1994). This relative resistance may have genetic correlates, such as the decreasing frequency of the apo E e4 allele in the population with advancing age (Rebeck et al., 1994). Centenarians may thus represent a valuable cohort for the study of genetic and environmental factors associated with a decreased susceptibility to diseases associated with aging, such as AD.

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Journal of Gerontology: Biological Sciences

The Gerontological Society of America’s Publications Committee is seeking nominations for the position of Editor of the Journal of Gerontology: Biological Sciences.

The position will become effective January 1, 2002. The Editor makes appointments to the journal’s editorial board and develops policies in accordance with the scope statement prepared by the Publications Committee and approved by Council (see the journal’s masthead page). The Editor works with reviewers and has the final responsibility for the acceptance of articles for his/her journal. The editorship is a voluntary position. Candidates must be dedicated to developing a premier scientific journal.

Nominations and applications may be made by self or others, but must be accompanied by the candidate’s curriculum vitae and a statement of willingness to accept the position. All nominations and applications must be received by May 1, 2001. Nominations and applications should be sent to the GSA Publications Committee, Attn: Jennifer Campi, The Gerontological Society of America, 1030 15th Street, NW, Suite 250, Washington, DC 20005-1503.