Cognitive, Extrapyramidal, and Magnetic Resonance Imaging Predictors of Functional Impairment in Nondemented Older Community Dwellers: The Sydney Older Person Study

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(See editorial comments by Dr. Donald Royall on pp 163–165)

OBJECTIVES: To identify the clinical correlates of functional incapacity in the community living "old-old."

DESIGN: Cross-sectional.

SETTING: Community-based.

PARTICIPANTS: One hundred six nondemented people aged 80 to 94.

MEASUREMENTS: Participants were medically and cognitively assessed, underwent magnetic resonance imaging scanning (MRI), and were interviewed regarding their functional status: activities of daily living (ADLs), instrumental ADLs (IADLs), and the complex IADL functions of reading, hobbies, and socializing.

RESULTS: Dependency in IADLs, but not ADLs, was present. After controlling for age, sex, and education, extrapyramidal (EP) signs were significantly associated with two of the three IADLs, with EP signs comprising a composite score of 10 EP signs (e.g., resting tremor) and a 5-meter timed walk. Cognitive test performance on a range of tests was also associated with functional status. A hierarchical model confirmed the association between the EP signs and cognitive test performance and functional scores, but no "pattern" of cognitive association emerged. Hippocampal volume was associated with socializing.

CONCLUSION: This study has shown that many nondemented very old people living in the community are losing capacity to perform IADL functions and that areas of incapacity are associated with the presence of EP signs and impaired cognition. These results highlight the need for health workers to include an assessment of EP and cognitive status in their evaluation of older persons living in the community, even in the context of a lack of dementia diagnosis. Furthermore, it signifies the need to directly evaluate IADL function to identify need for intervention and support if required. This group of old-old individuals may now be considered the "survivors" of their cohort, and early detection of the difficulties they are experiencing will enable clinicians to respond appropriately, thus providing them a higher quality of life for their years to come. **J Am Geriatr Soc 54:3–10, 2006.**

Key words: functional impairment; normal elderly; cognition; mild cognitive impairment

"Old-old" individuals are the fastest-growing segment of the population in developed countries. The incidence of dementia, as well as milder forms of cognitive impairment, is greatest in this age group.[1–4] Although presence of dementia is well recognized as being associated with functional incapacity, and its presence is usually required for diagnosis,[5] the functional capacity of older people who do not suffer from dementia yet may be in need of support and services remains unclear.

In past decades, research on aging and functional incapacity has centered on dementia and its clinical associations. Dementia research has more recently turned to the detection of cognitive changes that precede clinical dementia, a condition broadly referred to as mild cognitive impairment (MCI).[6,7] Common to most MCI definitions is the

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absence, or minimal effect, in them of any cognitive changes on functional capacity in terms of activities of daily living (ADLs; e.g., dressing, feeding, toileting).[8] Such definitions of MCI have implications for the interpretation of research on the functional status of older individuals, because people with MCI will typically be included in any sample of nondemented elderly people. In this context, there have been a number of studies that have identified functional impairments in some groups of nondemented older people.

For example, a review of the literature described a link between instrumental activities of daily living (IADLs; e.g., shopping, cooking, housework) and cognition in nondemented elderly individuals.[9] This association has been reported in unselected older populations[8] and in clinically defined groups with MCI.[10] Population-based studies of aging have found extrapyramidal (EP) signs,[11] depression,[11–13] and executive or visuospatial deficits[8,14,15] to be associated with functional impairment. One study of MCI groups[10] found impairments in IADLs, as well as other "higher order" or "advanced" activities such as preparing tax records and writing checks, and another identified mild impairments in capacity to manage their finances.[16]

Thus, there is evidence of a relationship between cognitive and motor deficits, as well as presence of depression, and functional impairment in nondemented individuals, in particular for IADL functions, although the independent relationship between these variables and functional status remains unclear. Furthermore, of the studies cited above, all examined subjects with average ages in their 70 s at most and only examined a limited range of variables. Whether this relationship holds in the old-old, where the implications for this association are greatest, is uncertain.

The first aim of this study was to determine the prevalence of functional incapacity in a group of old-old community-living nondemented individuals. The second aim was to identify the clinical correlates of different types of functional incapacity. Aspects of functional capacity evaluated included ADLs and IADLs, as well as other complex activities such as reading and socializing. To assist clinicians in their evaluation and support of older people, a broad range of indicators potentially associated with functional decline were examined. These indicators conceptually encompassed information available at clinical assessment, such as cognitive and psychological status, as well as EP signs and brain imaging. The ethics committee of Concord Hospital approved this research project, and written informed consent was obtained from all participants.

METHODS

Participants

Participants were recruited from the 6-year review of the Sydney Older Persons Study (SOPS). SOPS is a longitudinal study following an initial random sample of 630 community dwellers from the inner west region of Sydney, Australia, aged 75 and older at the time of recruitment. The background to SOPS has been published previously.[17,18] Participants were comprehensively evaluated on three occasions over 6 years. In this study, no a priori exclusion criteria were applied, to maintain an accurate reflection of community-living people's abilities and deficits in this age band.

Of the 299 SOPS participants assessed at 6 years, 167 (56%) agreed to participate in the more-detailed MRI study. Participants were only excluded if they were not capable of giving consent for the cognitive testing or MRI procedures, if they were practically unable to participate (e.g., sickness), met MRI exclusion criteria (e.g., cardiac pacemaker or claustrophobia), were demented according to the Clinical Dementia Rating scale (CDR; i.e., score of $\geq$1),[19] or had a Mini-Mental State Examination (MMSE)[20] score of less than 22. This resulted in a sample of 106 community-living, nondemented individuals. Qualified clinicians conducted all medical examinations and cognitive assessments.

The CDR was selected as the method to exclude participants with dementia, because it has been shown to be a sensitive method of distinguishing normal aging from early dementia;[21] it has been used in previous studies evaluating functional status and cognition;[22] and in a previous study on an earlier review of this same sample, a correlation of 0.89 was found between the informant CDR and clinical (geriatrician) dementia diagnosis[23] using *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* criteria.[5] Given the close relationship demonstrated between CDR and geriatrician dementia diagnosis in this sample, a MMSE score of less than 22 was chosen as the additional cutoff to retain a representation of the full range of community-living elderly. Such a span of MMSE scores for nondemented older people is consistent with the findings from other community-based samples.[24]

Retention of participants across waves was reasonable for a longitudinal study of this age group, with 47% of the original sample being available for assessment at 6 years, of whom 35% were able to participate in the MRI procedures (17% of original sample). The dropout from this study was mainly due to illness or death. Those who had died by the 6-year follow-up were older, more likely to be male, and more cognitively impaired at the baseline SOPS assessment. Refusal and noncontacts did not differ in age or MMSE score at baseline.[25]

Participant Interview and Functional Capacity

Participants were interviewed on a range of health measures and questionnaires, including medical history, lifestyle, medication, diet, level of activity, social network, and psychological well-being. Reading activity during the previous 6 months, active participation in a hobby, and involvement in social occasions during the previous 3 months were also investigated. These latter three recreational/intellectual variables were regarded as "complex" IADLs. Unlike the standard IADL functions described below, they are not closely linked to basic survival in the home.

Informant Interview and Functional Capacity

A nominated informant was interviewed about the medical, cognitive, functional, and behavioral status of the participant. This information was used to determine the CDR score for each participant: 0 (no cognitive impairment) or 0.5 ("questionable" dementia). A CDR score of 0.5 was used in this study as a marker of MCI. This score has been used in previous studies to signify MCI[22] and has also been shown to be associated with subsequent progression to

dementia.[26] ADL (dressing, feeding, and toileting) and IADL (cooking, housework, and shopping) status was determined using the Kilsyth Disability Rating Scale.[27] All items were rated on a scale of 1 to 3 (ADL) or 1 to 4 (IADL), higher scores indicating increasing loss of independence.

Cognitive and Behavioral Measures

In addition to a measure of general cognition (MMSE), tests measuring the integrity of specific cognitive domains were administered:

Attention/Information-Processing: Digits Forward and Backward subtests from the Wechsler Memory Scale—Revised (WMS-R)[28]
Language: Boston Naming Test[29] and Semantic Verbal Fluency Test (animals)[30]
Spatial skills: a subset of 20 items from Judgment of Line Orientation Test[31] and copy of a cube drawing task[32]
Memory: the WMS-R[28] Logical Memory and Visual Reproduction percentage retention indexes
Executive function: Oral Trail Making Test—Part B[33] and Similarities subtest from the Wechsler Adult Intelligence Scale—Revised[28]

The presence of depressive symptomatology was identified using the Center for Epidemiological Studies Depression Scale (CES-D).[34]

Motor Measures

Two EP measures were collected as part of a comprehensive medical and neurological examination. The first was a composite EP score as previously established and used in previous SOPS waves.[1,18] Briefly, this score is composed of 10 separate variables (e.g., resting tremor, limb rigidity, cogwheeling, postural flexion). Each variable is scored individually before summing the components into a composite score. The second EP measure (slowing) was a 5-meter timed walk, controlling for the presence of mechanical slowing (e.g., lower limb arthritis).[35]

Brain Imaging

Brain MRI was performed within 1 month of the clinical assessments using a 1.5 T Signa scanner (General Electric Medical Systems, Milwaukee, WI). Two sequences were obtained in the horizontal plane: a FSE2 (TR/TE = 3,600/108 ms, 5-mm thick slices with 2.5-mm gap, 22-cm field of view (FOV), and a 256 × 256 matrix) and a FLAIR (TR/TE = 10,000/140 ms, 4-mm-thick contiguous slices, 22-cm FOV, and a 256 × 256 matrix). In addition, a T1-weighted three-dimensional fast spoiled gradient echo sequence was also performed in the coronal plane (TR/TE = 12/3.5 ms, 30° flip angle, 1.5-mm thick contiguous slices, 22-cm FOV, and a 256 × 256 matrix). The presence of white matter lesions (WMLs) was determined using FLAIR images; volumetric measurements of the hippocampus and whole brain were derived from the T1 images. Ratings for WMLs and volume measurements have been reported previously.[36,37] Briefly, periventricular WMLs were recorded in three regions (frontal caps, lateral bands, and occipital caps) and summed into a composite score. A composite index of deep WMLs was also created, taking into account the size and the number of lesions in four brain regions (frontal, temporal, parietal, and occipital). Hippocampal and whole-brain volume measurements were obtained using ANALYZE PC AVW 3.0 (Biomedical Imaging Resource, Mayo Foundation, Rochester, MN). The hippocampus was defined using an established tracing protocol[30] described previously.[31] The hippocampal volumes reported were corrected for intersubject variation in head size (i.e., whole-brain volume corrected). Trained raters who were blind to all clinical data undertook all the image processing.

Statistical Analysis

The data were analyzed using regression analyses. First, partial regression analyses were performed to examine the relationship between the independent (e.g., clinical) and dependent (i.e., functional) variables, controlling for age, sex, and education. After this, hierarchical regression analysis was performed, in which three blocks of variables were entered into the regression equation. In this approach, when the second and third block of variables are added, the previously analyzed block(s) of variables are held in the model to identify the independent strength of relationships. The first block entered contained the demographic characteristics of participants (age, sex, education); followed by the second block, containing the EP and MRI variables; followed by the cognitive and depression variables. The ease of access to the types of information by clinicians guided the order of entry into the model. All analyses were performed using the SPSS for Windows, release 12 (SPSS, Inc., Chicago, IL). The significance level was set at .05 for all analyses.

RESULTS

The average age of the sample was 85.2, with 10 years of education on average (Table 1). Average MMSE score was 27.03, with a range of 22 to 30. Most participants reported low levels of depressive symptomatology. Of the 106 participants, 51 were female and 55 male. Sixty-four had a CDR score of 0 (no dementia), and another 42 had a CDR score of 0.5 (questionable dementia/MCI).

Functional Capacity

Consistent with the absence of demented individuals in the sample, all participants were found to be independent in the ADL functions of dressing, feeding, and toileting. For this reason, ADL status was not considered in the statistical analyses. Although many of the participants were independent in the Kilsyth IADLs (Table 2), some level of dependency was noted for each of the variables. For this, most independence was found for cooking and least for housework. For the complex IADL skills, there was a broad spread of engagement in recreational/intellectual activities, ranging from no engagement in the activities to frequent engagement. Of the three activities, socializing was the activity most engaged in across participants.

Partial Regression Analyses

As seen in Table 3, the results of the partial regression equations (controlling for age, sex, and education) revealed significant associations between the two motor measures and shopping, with EP signs showing an additional

Table 1. Basic Descriptive Data

Characteristic	Value	
Age, mean ± SD (range)	85.2 ± 2.9	(80.9–94.4)
Education, years, mean ± SD (range)	10.4 ± 2.1	(7–19)
Sex, male/female, n	55/51	
Extrapyramidal signs, % (maximum = 10)		
0	46	
1	39	
2–3	15	
Timed walk, seconds, mean ± SD (range)	12.9 ± 4.8	(5.0–45.0)
White matter, mm^3, mean ± SD (range)	39.7 ± 33.7	(0.0–186.0)
Periventricular, mm, mean ± SD (range)	17.9 ± 9.5	(3.0–48.5)
Left hippocampus, mean ± SD (range)	32.97 ± 414.5	(21.0–41.7)
Right hippocampus, mean ± SD (range)	34.0 ± 436.4	(20.9–43.6)
Clinical Dementia Rating, n (%)		
0	64 (60.4)	
0.5	42 (39.6)	
Mini-Mental State Examination score (maximum = 30), mean ± SD (range)	27.0 ± 2.3	(22–30)
Center for Epidemiological Studies-Depression Scale score (maximum = 60), mean ± SD (range)	7.5 ± 8.5	(0–52)
Digits forward, mean ± SD (range)	6.0 ± 1.1	(4–9)
Digits backward, mean ± SD (range)	4.2 ± 0.9	(2–7)
Boston Naming Test score (maximum = 60), mean ± SD (range)	47.5 ± 7.5	(28–60)
Semantic Verbal Fluency score, mean ± SD (range)	13.8 ± 4.2	(6–31)
Judgment of Line Orientation Test score (maximum = 30), mean ± SD (range)	17.0 ± 8.0	(8–20)
Cube copying (maximum = 6), mean ± SD (range)	5.0 ± 1.3	(1–6)
Logical Memory percentage recall (maximum = 100%), mean ± SD (range)	68.3 ± 24.3%	(0–100)
Visual Reproduction percentage recall (maximum = 100%), mean ± SD (range)	54.7 ± 29.4%	(0–100)
Oral Trails, mean ± SD (range)	− 0.1 ± 0.9	(− 1.12–3.14)
Similarities (maximum = 28), mean ± SD (range)	12.7 ± 6.9	(0–27)

SD = standard deviation.

association with housework and shopping. The white matter measures were not associated with any of the functional variables, but left and right hippocampus volumes were associated with extent of socializing: the larger the hippocampus, the more frequently the person socialized.

Of the cognitive functions, CDR status was not associated with any of the functional variables, and MMSE score was associated only with hobbies. For the neuropsychological tests, Boston Naming Test and Digits Forward performance made significant contributions to cooking and shopping, respectively (Table 3). Five verbal and nonverbal cognitive variables were associated with housework. Performance on three verbal cognitive test was associated with reading and hobbies. CES-D score was significantly related to housework and shopping.

Hierarchical Regression Model

When the block of demographic variables was entered into the regression model, no individual variable emerged as being independently and significantly associated, although these variables as a group were significantly associated with shopping and reading, accounting for 16% and 7% of the variance, respectively. The addition of the EP and MRI block to the model identified EP signs as being independently associated with cooking and housework and left hippocampus as being independently associated with socializing.

The final addition of the cognitive block to the model identified Digits Backward and Logical Memory percentage retention to be independently associated with cooking, Oral Trail Making Test with housework, Digits Forward with shopping, and Digits Backward and Similarities with reading. There were no independent associations identified between the cognitive variables, hobbies, socializing and none identified between CDR, MMSE, or CES-D and any of the functional variables.

Notwithstanding the relative lack of individual associations, the cognitive block as a whole accounted for 22% of the variance for cooking, which was statistically significant, with all three blocks together accounting for between 22% and 35% of the variance for all functional variables.

DISCUSSION

The results of this study show that a striking number of nondemented very old individuals living in the community exhibit impairment of IADL function, as well as reduced engagement in recreational and social activities. The actual prevalence of impairments in the broader community-living group may have been greater, because those suffering from illness, and otherwise unable to undergo the MRI procedures, may well have been disproportionately functionally

Table 2. Level of Dependency and Activity in Kilsyth and Complex IADL (N = 106)

Instrumental Activities of Daily Living	%
Kilsyth	
Cooking	
Independent	82
Some help	18
Dependent	0
Housework	
Independent	47
Some help	52
Dependent	1
Shopping	
Independent	57
Some help	39
Dependent	4
Complex	
Reading	43
Independent	8
Some help	21
Dependent	28
Hobbies	50
Independent	7
Some help	5
Dependent	38
Socializing	18
Independent	15
Some help	34
Dependent	33

compromised. Such impairments, which occur against a background of maintained ADL function, are associated with reduced quality of life for these people.

These findings of prevalence are not directly comparable with those of other studies, because each used different IADL instruments, and the majority of studies evaluated the associations with functional impairment rather than its prevalence. Nevertheless, although the relatively high prevalence of the informant-rated Kilsyth IADL impairments are likely to be an accurate representation of actual incapacity in those studied, it is possible that the self-rated reductions in the other complex IADLs were underestimated in this group. Studies have demonstrated that, even in groups of older nondemented persons, which will necessarily include people with MCI, informant and performance-based ratings of functional capacity are most accurate, because people with MCI tend to underestimate their own level of functional impairment.[22,38]

More specifically, this study found that EP signs were positively associated with the IADL functions. These significant associations between EP signs and increased dependency in cooking and housework confirm the French population-based study findings that showed an association between mild EP signs and functional impairment, particularly walking and incontinence.[11] Furthermore, the findings of the current study show that these relations are maintained from younger groups to the old-old.[13] Previous authors have speculated that the EP signs and functional impairments are the common effects of underlying central nervous system degeneration, which may well represent decline in nigrostriatal dopaminergic regulation that occurs in older age.[11] It is noteworthy that, in the current study, EP signs were not associated with the complex IADL functions, perhaps implicating a greater motor, rather than cognitive, component of the Kilsyth IADL tasks.

No association between WMLs and functional capacity was present in either group, in contrast to findings elsewhere.[39] It is possible that the brain changes recorded were not of sufficient severity to affect functional capacity, because a lack of association between these variables and executive function in the same cohort has previously been published.[35] Furthermore, unlike in a number of other studies,[39] all participants with dementia, who were likely to have the most severe lesions, were excluded.

Nevertheless, of the other imaging variables, smaller hippocampi were shown to be associated with less socializing, a finding that remained for left hippocampal volume in the final regression model. Although smaller hippocampi have been associated with MCI status,[40] the authors are unaware of any studies that have examined the functional correlates. A recent study evaluated the reasons for older people not participating in leisure activities and found that the most common reason given was lack of interest.[41] The authors speculated that the lack of interest may be secondary to depression or perhaps long-term behavior. They did not consider that lack of interest may be a clinical marker of early predementia neuropathological changes, in which withdrawal from activities well before clinical presentation has been reported.[42] This interpretation would be consistent with the findings from this study and with the concept that social withdrawal precedes detectable cognitive change,[42] which is associated with early involvement of the hippocampus and related structures,[43] although a follow-up of this cohort would be required to test this interpretation.

A number of community-based[14,44,45] and MCI studies[15] have identified an association between executive function and functional status and more recently spatial function.[8] In this study, the greatest number of cognitive associations in the partial regression analyses were found for housework, which may reflect the fact that, of the Kilsyth IADL tasks, more people lacked capacity to carry out the tasks independently, although overall, no one cognitive domain appeared selectively associated with functional status, with verbal, spatial, and executive tasks making contributions to the partial regression analyses. Similarly, for the final model, even though the cognitive tasks were associated with up to 22% of the variance, no pattern of cognitive association emerged. A possible explanation of this discordance with earlier studies is that different executive and spatial tasks were used, and thus the particular tests employed in this study were insensitive to the functional changes. For example, some of the executive tasks employed by studies that have demonstrated an association have required a motor response (e.g., drawing a clock[15] or the written form of Trails B[46]), whereas the two measures used in this study were entirely verbal.

These findings highlight the suggestion that, in older persons, a multifactorial approach to outcomes is crucial.[47] In a previous report on an earlier phase of this study, the effect of chronic systemic and neurological disorders on

Table 3. Partial Regression Analyses (Controlled for Age, Sex, and Education)

Variable	Kilsyth IADLs[‡]			Complex IADLs[§]		
	Cooking	Housework	Shopping	Reading	Hobbies	Socializing
EP signs and magnetic resonance imaging						
EP signs	0.118	0.183*	0.103†	−0.098	−0.119	0.136
Timed walk	0.015	0.025	0.020*	−0.016	0.009	0.005
White matter	0.001	0.001	0.001	0.004	−0.003	0.001
Periventricular	0.007	0.005	0.007	0.013	−0.014	0.005
Left hippocampus	0.000	0.000	0.000	0.000	0.000	−0.001†
Right hippocampus	0.000	0.000	0.000	0.000	0.000	−0.001*
Cognitive[‖]						
CDR	−0.032	0.173	0.165	−0.202	−0.397	−0.145
Mini-Mental State Examination	−0.017	−0.045	−0.043	0.071	0.181†	−0.056
Attention/working memory						
Digits Forward	0.007	−0.057	0.048†	0.023	0.084	0.114
Digits Backward	−0.006	−0.029	−0.044	−0.058	0.257	0.122
Language						
Boston Naming Test	−0.018†	−0.018*	−0.005	0.040*	0.059†	0.001
Semantic Verbal Fluency	−0.008	−0.027†	−0.002	0.058*	0.033	0.000
Spatial skills						
Judgment of Line Orientation	−0.018	−0.042*	−0.041	−0.023	0.110	−0.002
Cube Copying	−0.056	−0.081*	−0.069	−0.067	0.196	−0.146
Memory						
Logical Memory percentage retention	−0.003	−0.004	−0.002	0.007	0.004	0.001
Visual Reproduction percentage retention	−0.002	−0.004*	−0.002	−0.001	0.004	0.001
Executive function						
Oral Trails	0.067	0.064	0.088	−0.077	−0.522†	0.039
Similarities	−0.003	−0.003	−0.007	0.058†	0.073†	−0.014
CES-D	0.004	0.014*	0.013*	−0.003	0.006	−0.014

* $P < .05$, † .01.

‡ Higher scores for Kilsyth instrumental activities of daily living (IADLs) indicate greater levels of dependency (worse).

§ Higher scores for complex IADLs indicate greater levels of activity (better).

‖ For most cognitive variables, higher scores indicate better performance: exception for Clinical Dementia Rating (CDR) for which the higher score indicates worse cognition (mild cognitive impairment); and Center for Epidemiological Studies Depression Scale (CES-D), for which higher scores indicate greater levels of depression.

EP = extrapyramidal.

functional decline and life satisfaction was evaluated.[12] It was found that many of the physical disorders had a significant effect on disability and quality of life. The purpose of the current study was to conduct a more-focused examination of the contributions of cognitive and EP signs to functional decline, but it is likely that, if those other physical and social factors had been added to this analysis, a greater percentage of the variance may have been accounted for. This approach is consistent with the view that the needs and outcomes of older people become increasingly complex and determined by a wide range of factors.[47,48]

In keeping with other studies, the current study found that, for the partial and hierarchical analyses, CDR score and MMSE played a small role and could not be considered to be of clinical (or statistical) utility,[47] although this finding, together with a documented preservation of ADL function in this group, supports the likelihood that people with dementia were not included in this sample. Although these instruments are helpful in staging dementia severity, they appear to lack sensitivity in the old-old to contribute to important clinical constructs such as functional capacity in the predementia stage.

Presence of depressive symptomatology was found to be associated with functional dependence in housework and shopping in the partial analyses only. Impairment of IADL status has been found in clinically depressed populations with MCI[13] and in population-based samples of the young-old.[11,12,14] Such findings may be accounted for on the basis of the demonstrated relationship between depressive symptoms and other symptoms and signs, such as EP signs and medical condition,[12,13] and when these are controlled for the relationship is lost. One study pointed to the colinearity of EP signs and depression and, as cited above, raised the possibility of the dopaminergic system being a common underlying mechanism.[11]

This study has some limitations. Although the use of informant-based functional information is standard practice, self-report or observational information would have been informative for contrast. Also, it is unclear from these IADL variables whether the subjects had longstanding

reductions in activity or whether these reflected more-recent changes. The use of the CDR as a marker of MCI may also be seen as a limitation, even though it has been employed in other studies to determine MCI.[49] The lack of clinical functional utility of the CDR is consistent with the fact that there remains a lack of consensus for definitive criteria, and more work is required in this area.[7,50]

Nevertheless, in keeping with commonly applied definitions of MCI, all participants in this study were found to be independent in all ADL functions. The emerging controversy in the literature has concerned whether impairments in IADL functions should be included within MCI classifications.[22] Although this study was not able to address this matter directly, the implications of this study, and others, that impairment in IADL function is highly multifactorial makes the practicality of this suggestion, on a population basis, unlikely. In keeping with this, one report on the Canadian Study of Health and Aging found that, although including impairment in IADL function in the definition of MCI increased prevalence figures, its inclusion did not affect outcome (i.e., risk of institutionalization or dementia).[51] Thus, the determinants of IADL status are well beyond the more-limited cognitive and motor constructs and should perhaps not be used to support a diagnosis of MCI.

The strengths of this study are its sample and the instruments used. It is based on a well-defined, population-based sample of the old-old. Also, the results are based on variables readily available to clinicians evaluating this population. The cognitive tests are commonly used clinically, and the gathering of informant information is also standard practice and applicable to clinical situations. Imaging data are also becoming routinely available. Furthermore, the use of partial and then hierarchical analyses allowed for the determination of the relative independence of variables.

This study has shown that, although independent in ADL function, many nondemented older people living in the community are losing capacity to perform IADL functions and show withdrawal from social and recreational activities. Such identification of functional incapacity is important when considered in the light of mortality research, in which functional deterioration in older age groups has been shown to augur poorly for longevity.[52] The results of this study have shown that EP signs have a strong and independent relationship with IADL function, as does poor performance on a number of cognitive tests. These results highlight the need for health workers to include an assessment of EP and cognitive status in their evaluation of older persons living in the community, even in the context of a lack of dementia diagnosis. Furthermore, it signifies the need to evaluate IADL function directly to identify need for intervention and support if required. This group of old-old individuals may now be considered the "survivors" of their cohort, and early detection of the difficulties they are experiencing will enable clinicians to respond appropriately, thus providing them a higher quality of life for years to come.

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