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Functional assessment scales in detecting dementia

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Abstract

Aim: to evaluate the use of different functional scales in detecting dementia in a population study.
Methods: the study is part of the Helsinki Ageing Study. A random sample of 795 subjects aged 75 ($n = 274$), 80 ($n = 266$) and 85 years ($n = 255$) was taken. The prevalences of dementia (DSM-III-R criteria) in these age groups were 4.6, 13.1 and 26.7% respectively. The functional scale scores were known for 71% of the non-demented and 66% of the demented subjects. A structured questionnaire completed by a close informant included four functional scales: the index of activities of daily living (ADL), the modified Blessed dementia scale (DS), the instrumental activities of daily living scale (IADL) and the Functional Assessment Questionnaire (FAQ).
Results: all the functional scales discriminated demented from non-demented subjects. Based on receiver operating characteristics analysis, the area under the curve (95% confidence interval) was 0.90 (0.80–0.94) for the ADL, 0.94 (0.87–0.97) for the DS, 0.95 (0.90–0.98) for the IADL and 0.96 (0.92–0.98) for the FAQ. The effects of age, sex and education in detecting dementia were minor or non-existent in the ADL, DS and FAQ scales, but age had an effect on the performance of the IADL scale. All the scales detected even mild dementia adequately.
Conclusions: functional scales can be used in detecting dementia when functional assessment is already used for other purposes, such as among elderly primary care patients.

Keywords: *activities of daily living, dementia, disability, instrumental activities of daily living, screening*

Introduction

Early detection of dementia is important for the emerging treatment possibilities, to support independent functioning and to postpone the need for institutional placement [1, 2]. Accurate prevalence figures are essential for planning health policy, services and manpower needs [3, 4].

Cognitive scales such as the Mini-Mental State Examination (MMSE) [5] have been used in population surveys as the first stage of screening for dementia [6–8]. One of their problems has been an educational bias [9], and education-adjusted norms have been established in the USA [10]. Despite their flaws such tests are needed in surveys. It is more difficult to use cognitive tests as case-finding tools in primary care: the very administration of such a test may be demeaning to a patient, and requires a pre-existing suspicion of cognitive decline. A tool that would adequately elicit such a suspicion in primary care would improve the early detection of dementia.

Dementia refers to cognitive decline sufficient to cause disability. Thus, functional scales reflecting social abilities can also be used in screening dementia [11]. These functional scales may be less biased by education than cognitive scales [12]. There is also some merit in using a tool with multiple purposes in clinical settings. Only a few functional scales have been validated in the screening of dementia [11] and no comparative studies are available.

The aim of this study was to compare the accuracy of four different functional scales with varying complexity in detecting dementia in a random sample of elderly people.

Subjects and methods

The Helsinki Ageing Study is based on a random sample of 75-year-old ($n = 274$), 80-year-old ($n = 266$) and 85-year-old ($n = 255$) people. Of the whole sample, 656 (83%) subjects took part in the study, and in the

above-mentioned age groups the participation percentages were 88, 80 and 79% respectively. Details of the study protocol have been published previously [13].

All subjects were interviewed by a public health nurse and examined by a trained general practitioner (GP). The interview included the MMSE [5] and an assessment for functional capacity. This included 17 different items from moving around and carrying things to using the telephone, doing housework and handling finances. The examination by the GP included a structured medical history, clinical examination and the Clinical Dementia Rating scale [14, 15].

The Clinical Dementia Rating scale was used as a first-stage screening method, and 174 subjects where further evaluated by a trained neurologist in the second phase. For those not included in the second phase, dementia was ruled out by analysing the MMSE score, functional capacity and other available information [13]. The diagnosis of dementia and the assessment of the degree of dementia were based on the DSM-III-R criteria [16]. The assessments incorporated information from a clinical assessment, including a neurological examination, an MMSE scale and an interview with a close informant when possible. In some cases radiological and laboratory examinations were carried out. In this study we were not able to systematically assess the underlying aetiology of the dementia syndrome. Education was stratified as low education (grade-school or less) or high (grammar school or more).

Ninety-three subjects fulfilled the criteria for dementia. The prevalences of dementia in the groups of 75-, 80- and 85-year-olds were 4.6, 13.1 and 26.7% respectively. The proportions of mild, moderate and severe dementia according to the DSM-III-R criteria were 18.3, 37.6 and 44.1% respectively. The were no differences in prevalences between the sexes [13].

The functional capacity was assessed by a close informant. A structured questionnaire including four functional scales was sent to a relative or other informant of the subject. The scales from the most basic to the most complex functions were the index of activities of daily living (ADL) [17], the modified Blessed dementia scale (DS) [18, 19], the instrumental activities of daily living scale (IADL) [20] and the Functional Activities Questionnaire (FAQ) [21].

The ADL measures six basic functions and is scored from A (independent in every item) to G (dependent in all functions). The DS consists of items measuring both ADL and instrumental ADL functions. Three ADL functions (eating, dressing and continence) are scored from 0 to 3 and eight items assessing changes in everyday activities, such as performing household tasks, coping with money or finding one's way, are scored 0, 0.5 or 1. The total score ranges thus from 0 (independent) to 17 (dependent). The IADL measures different instrumental functions. It includes eight items, and the score ranges from 8 (able to perform all the functions) to 0 (cannot perform any of the

Table 1. The characteristics of demented and non-demented subjects with and without a completed close informant's questionnaire

	No. of patients, by questionnaire availability/dementia			
	Available		Missing	
Factor	Non-demented	Demented	Non-demented	Demented
Age (years)				
75	167	5	62	6
80	134	21	52	7
85	96	35	52	19
Sex				
Female	286	49	125	19
Male	111	12	41	13
Education[a]				
High	107	5	32	6
Low	279	35	114	9
Missing	11	21	20	17
Functional capacity[b]				
Good	104	4	38	3
Fair	196	11	92	2
Poor	96	46	34	26
Missing	1	0	2	1
All	397	61	166	32

[a]High, grammar school or more; low, primary school or less.
[b]Good, no problems; fair, 1-5 problems; poor, >5 problems (out of 17).

functions). The FAQ includes 10 items and has been developed from the IADL scale. It assesses shopping, handling finances, preparing a meal and travelling (which are also in the IADL scale), remembering appointments, and paying attention to, understanding and discussing television, a book or a magazine. The total score ranges from 0 (independent) to 30 (dependent).

In the close informant's questionnaire at least one of the scales was fully completed in 397 (71%) of the non-demented and 61 (66%) of the demented subjects. The corresponding figures were 379 (67%) and 58 (62%) for the ADL scale, 360 (64%) and 31 (33%) for the DS, 368 (65%) and 58 (62%) for the IADL and 317 (56%) and 53 (57%) for the FAQ.

The prevalence of dementia was not dependent on the completion of the close informant's questionnaire. There were no sex differences between those who had the questionnaire completed and those who had not (Table 1). Among the non-demented population there were no differences between those with and without a completed questionnaire in the functional capacity, measured by the number of functions impaired in the public health nurse's interview. Among the demented subjects, the questionnaire was more often completed for subjects suffering from mild or moderate dementia than for those with severe dementia. The difference was not statistically significant.

The distributions of the different functional scales were highly skewed. Thus the screening of demographic variables for possible confounding was done by a Kruskal-Wallis analysis of variance [22] among the reference group (non-demented subjects).

The receiver operating characteristic (ROC) analysis combines the sensitivity and specificity over the whole range of responses of any used diagnostic method in one curve, the estimated binormal ROC curve. The curve consists of different sensitivity/specificity pairs. The area under any ROC curve can then be calculated. The larger the area under curve (AUC), the better the discriminating capacity [23, 24]. The analyses were performed with the LABROC1 program [23, 24].

The ROC analyses were carried out on the total population and the relevant confounding variables for each scale were stratified. For each ROC curve, the estimated function is presented, with 95% confidence intervals (CI) and the estimated AUC. Also, an 'optimal' operating point with its associated cut-off point is

Table 2. Distribution of scores on different functional scales and the number and proportion of demented subjects within each response category

	Number Responses	Demented	Prevalence of dementia (%)
Activities of daily living			
Missing	219	35	16
A	326	11	3
B-C	76	19	25
D-E	15	9	60
F-G	20	19	95
Instrumental activities of daily living scale			
Missing	232	37	16
0	22	21	95
1-2	38	22	58
3-4	44	8	18
5-8	320	5	2
Functional Activities Questionnaire			
Missing	286	40	14
1-7	270	3	1
8-15	31	3	10
16-23	24	10	42
23-30	45	37	82
Modified Blessed dementia scale			
Missing	265	62	23
0-1	301	5	2
1.5-5.5	67	11	16
6-10	19	11	58
10.5-16	4	4	100
All	656	93	14

Table 3. Relationship of demographic variables with different scales

Variable	All subjects χ^2	P^a	Non-demented subjects χ^2	P^a
Activities of daily living				
Age	56.6	<0.0001	30.35	<0.0001
Sex	0.01	0.921	0.18	0.671
Education	2.45	0.485	0.98	0.805
Instrumental activities of daily living scale				
Age	61.2	<0.0001	33.63	<0.0001
Sex	13.7	0.0002	23.66	<0.0001
Education	3.4	0.331	1.61	0.656
Functional Activities Questionnaire				
Age	75.1	<0.0001	48.25	<0.0001
Sex	0.1	0.740	0.04	0.847
Education	10.10	0.018	9.92	0.019
Modified Blessed dementia scale				
Age	37.6	<0.0001	24.53	<0.0001
Sex	0.66	0.417	2.40	0.083
Education	4.14	0.247	2.52	0.472

[a]Kruskal-Wallis test.

shown on each curve, so that a sensitivity of at least 90% is reached, if possible.

Staging the severity of dementia is based partly on functional capacity. Thus, the degree of dementia is inevitably highly correlated with the functional scales. In order to find out whether these functional scales also work in detecting mild dementia among an apparently non-demented population—which is the critical point in screening—we also carried out the ROC analysis separately for mild dementia (removing the moderate and severe cases) and for moderate to severe dementia (combining those with mild dementia with the non-demented population). There were no differences in sex or education between subjects with different degrees of dementia. The mildly demented patients were younger than those with moderate or severe dementia [13].

Results

The distribution of the total scores on the four scales, including details of missing data, is shown in Table 2.

Age had a significant effect on the total score of all the scales studied according to nonparametric analysis of variance. Among the non-demented subjects sex had an effect only on the IADL and education on the FAQ (Table 3).

All the functional scales discriminated well between demented and non-demented subjects (Figure 1). As Table 4 shows, the AUC ranged from 0.90 (ADL) to 0.97 (FAQ).

For the ADL, DS and FAQ, there were no striking differences in the AUC figures between the different age groups in detecting dementia. The IADL scale was somewhat sensitive to the effects of age, but the effect of sex was subtle (Figure 2). Although education could have confounded the FAQ, only five of the 53 demented patients with a complete FAQ had a grammar school education or more. All of these had FAQ points 25-30, so no statistical testing of the education effect was possible.

For mildly demented patients (with the moderate and severe cases removed) the AUC figures were still high (Table 4), although somewhat lower than for the whole population. However, the discriminating efficiency did not increase significantly if only moderate and severe dementia were included (Table 4).

To find an optimal screening efficiency we searched for a cut-off point representing a sensitivity of at least 90%. If, for instance, a patient has an FAQ score of 8 or more, further diagnostic procedures should be performed to verify possible dementia. The results of such a policy are shown in Table 5 for each of the functional scales evaluated.

Age affects the optimal cut-off points of the IADL. Among the 75-year-olds a score of <8 gives a sensitivity of 83 % and among the 80-year-olds a score of <5 gives a sensitivity of 93 %. For the FAQ, the optimal cut-off point is >7, which gives a sensitivity of 94% and a specificity of 84%.

Discussion

The prevalence of dementia in different age groups in the whole study is similar to that of the sample for whom functional scales were completed. There were

Table 4. The area under curve (AUC) derived from the receiving operating characteristic in detecting dementia using different functional scales

Functional scale/group	AUC	95% confidence interval
Activities of daily living		
Age (years)		
75	0.84	0.24–0.98
80	0.89	0.66–0.97
85	0.85	0.70–0.93
Degree		
Mild[a]	0.87	0.64–0.95
Moderate–severe[b]	0.90	0.80–0.95
All	0.90	0.80–0.94
Modified Blessed dementia scale		
Age (years)		
75	0.96	0.54–0.99
80	0.95	0.77–0.99
85	0.90	0.76–0.97
Degree		
Mild[a]	0.91	0.74–0.97
Moderate–severe[b]	0.95	0.88–0.98
All	0.94	0.87–0.97
Instrumental activities of daily living scale		
Age (years)		
75	0.80	0.33–0.97
80	0.97	0.87–0.99
85	0.95	0.86–0.98
Sex		
Female	0.95	0.90–0.98
Male	0.97	0.78–0.99
Degree		
Mild[a]	0.87	0.69–0.95
Moderate–severe[b]	0.97	0.93–0.99
All	0.95	0.91–0.98
Functional Activities Questionnaire		
Age (years)		
75	0.97	0.53–0.99
80	0.98	0.89–0.99
85	0.94	0.83–0.98
Education		
Low	0.95	0.87–0.98
High	0.99	0.05–0.99
Degree		
Mild[a]	0.92	0.77–0.97
Moderate–severe[b]	0.97	0.91–0.99
All	0.96	0.92–0.98

[a] Detecting mild dementia when moderate and severe cases of dementia removed from the 'population at risk'.
[b] Mild dementia combined with the non-demented population.

Table 5. Results of a policy of screening for dementia with each of scales evaluated

Scale	Result (%)				
	Cut-off point	Sensitivity	Specificity	Percent positive	Positive predictive value
Katz ADL	>1	81	83	25	42
Blessed DS	>1	84	82	23	29
Lawton IADL	<5	91	86	25	49
Pfeffer FAQ	>7	94	84	27	50

ADL, activities of daily living; IADL, instrumental activities of daily living scale; DS, modified Blessed dementia scale; FAQ, Functional Activities Questionnaire.

no differences in sex or education. Thus, this study is representative for these age groups.

All the functional scales studied discriminated demented from non-demented subjects well in these age groups. All scales could also discriminate between mildly demented and non-demented subjects. When patients with moderate or severe dementia were excluded, however, a slight reduction on the discriminating power was observed. This somewhat diminishes the screening value of these scales.

Age was related to the performance of all of the functional scales among both demented and non-demented subjects. This may be due to the higher somatic morbidity among the older age groups, which

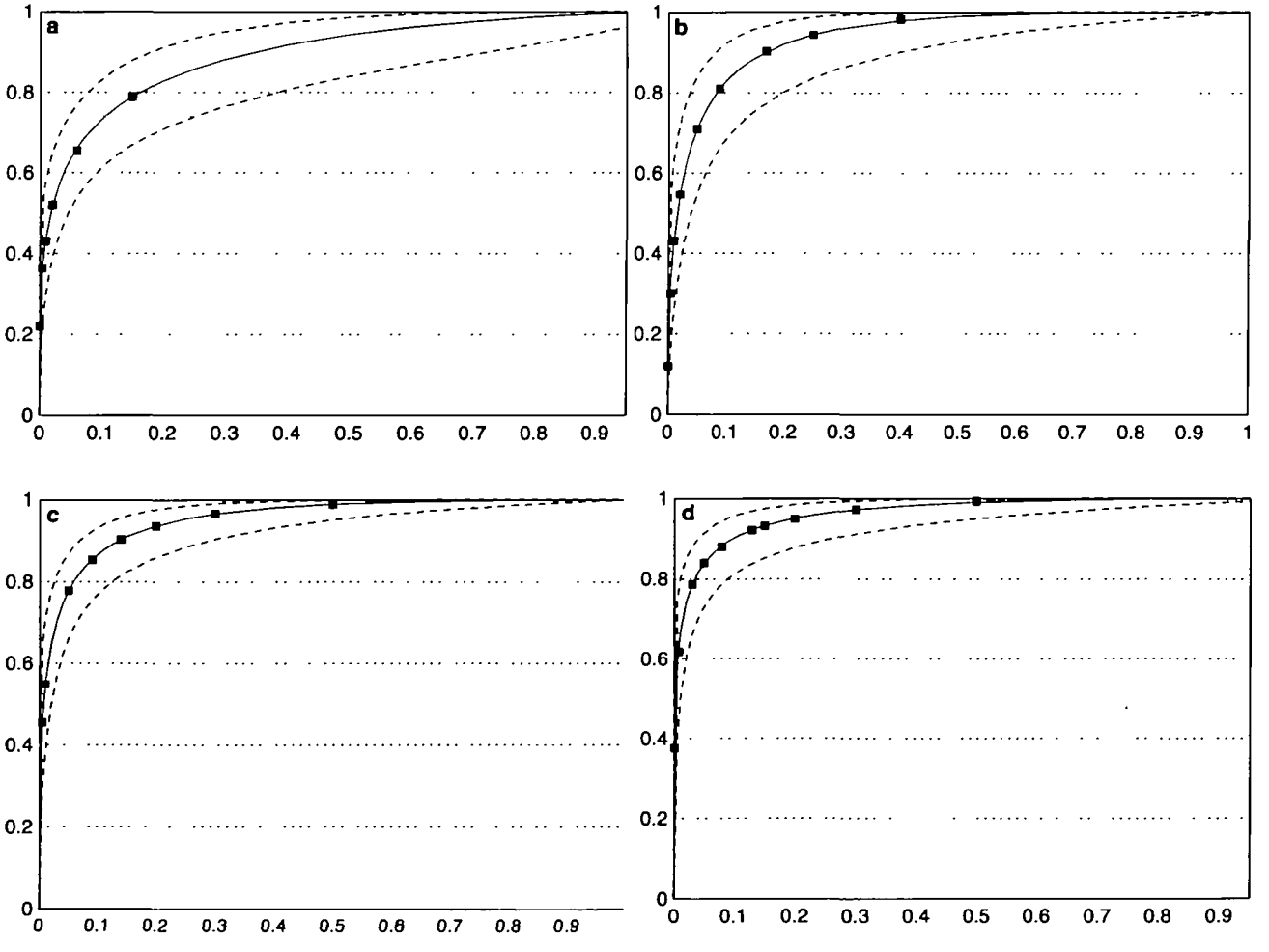

Figure 1. Receiver operating characteristics curves with 95% confidence intervals for detecting dementia using (a) activities of daily living scale, (b) modified Blessed dementia scale, (c) instrumental activities of daily living scale and (d) the Functional Activities Questionnaire. *x*-axis, true positive fraction (sensitivity); *y*-axis, false positive fraction (1-specificity).

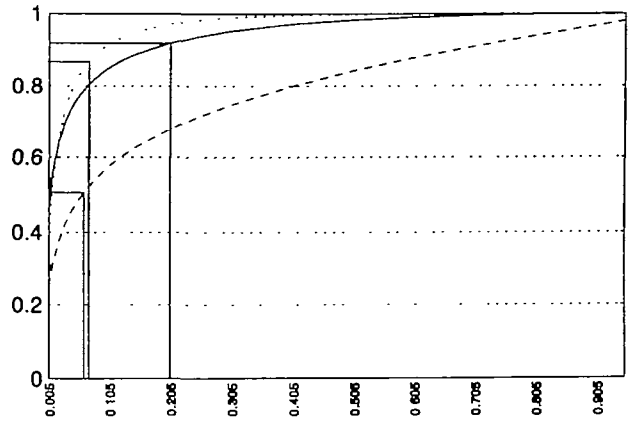

Figure 2. Receiver operating characteristics curve for detecting dementia in subjects aged 75 (- -), 80 (...) and 85 (—) years using the instrumental activities of daily living scale.

causes functional decline without associated cognitive impairment.

The good discriminating capacity of the functional scales in detecting dementia indicates that dementia is responsible for much functional disability in elderly people.

However, the estimated ROC curve does not tell the whole story, as the scales have a limited number of specific values and associated parameters. For instance, the ADL scale showed a floor effect and the critical level must be set at the minimum in order to achieve even the modest sensitivity of 81%. The IADL scale showed a similar floor effect in the younger age group.

The scales assessing more complex social functions proved to be better in detecting dementia than the scales reflecting basic ADL functions. The relatively poor discrimination of the ADL scale was because many of the mildly demented patients were still independent in ADL.

Subjects with different gender, educational background or age could well diverge in their functional abilities. In the present study, sex had an effect only on the IADL scale and education on the FAQ, and the effect was small enough not to change the optimal cut-off points for the scales. Even age did not have a large effect on the performance of the scales. Except for the IADL scale, the optimal cut-off points did not change from one age group to another.

In a case-finding strategy for dementia a constant cut-off point for all age, sex or educational groups is more practical to implement than age- and sex-specific cutpoints. However, there is a trade-off: in the younger age groups, the sensitivity is diminished; in the old, the specificity. Thus, in the younger age groups even a lower level of disability could indicate a need for a further assessment and follow-up.

Dementia has traditionally been screened with cognitive tests [6–8], although functional scales have also been used [11, 25]. The present study shows that functional scales assessing complex social functions can be used as case-finding tools for dementia. The sensitivity and specificity of these scales in a clinical setting may of course differ from those obtained in this population study. These scales also assess the capacity to function in a given environment and the need for support, which is an additional advantage in clinical practice.

When these functional scales are used in screening for dementia in the older age groups, about one-quarter of elderly subjects will be screened as positive and would require further evaluation. This follow-up assessment is important to avoid otherwise functionally impaired persons being wrongly labelled as demented. However, only about half of the further-evaluated group will have dementia, so the second-stage evaluation must also be simple and suitable for use in primary care. Usually some short cognitive test and a thorough clinical history and examination are adequate to separate demented patients from those with poor functional performance without significant cognitive decline.

Physicians and especially general practitioners should learn to use some of the functional scales as a component of a comprehensive health examination. If dementia can be detected as a by-product, that is a great advantage. We recommend using scales measuring complex IADL functions demanding cognitive capacity for routine functional assessment of elderly primary care patients and making use of the results in identifying possible cases of dementia.

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Key points

- The activities of daily living scale, instrumental activities of daily living scale, modified Blessed dementia scale and Functional Activities Questionnaire are all able to discriminate between demented and non-demented subjects and between mildly demented and non-demented subjects.
- The scales that assessed more complex social functions were better at detecting dementia than those that assessed basic activities of daily living.
- Functional scales can be used in detecting dementia when functional assessment is already used for other purposes, such as among elderly primary care patients.

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