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Cognitive impairment as predictor of functional dependence in an elderly sample

José Carlos Millán-Calenti [a,], Javier Tubío [a], Salvador Pita-Fernández [b], Sophie Rochette [a], Trinidad Lorenzo [a], Ana Maseda [a]

a Gerontology Research Group, Faculty of Health Sciences, University of A Coruña, Campus de Oza, E-15006, A Coruña, Spain
b Epidemiology Unit, Complejo Hospitalario Universitario de A Coruña, Xubias de Arriba, 84, E-15006 A Coruña, Spain

Abstract

This retrospective study determines the role of cognitive decline as a predictor of functional dependence. In a representative 600 community-dwellers aged 65 or older, we examined using a logistic regression model, the association between cognitive status (taking into account age and educational level) and dependence on basic and instrumental activities of daily living (ADL and IADL, resp.), controlling for socio-demographic variables and health conditions. The Mini-Mental State Examination (MMSE) scores were compared in participants with functional disability to perform basic and instrumental activities. Cognitive status influenced functional dependence on activities of daily living, basic (OR = 4.1, 95%CI = 2.7–6.1) and instrumental (OR = 5.7, 95%CI = 3.5–9.3), independently of gender, age, educational level and health conditions. Besides, cognitive impairment was associated with the dependence on certain basic (e.g., bathing, toileting) and instrumental (e.g., using the telephone, taking medications, and handling finances) activities. This was a gradual relationship, the highest cognitive decline implied the highest loss of ability at carrying out activities, with a larger impact on basic activities. These findings suggest that cognitive decline can be a predictor for functional dependence, independently of other variables, and turn into a very useful tool indicating the need for support.

Keywords: Cognitive impairment, Dependence of elderly, Functional disability

1. Introduction

Quality of life in older people depends on multiple health factors, in particular cognitive state and functional capacity. It is estimated that in Europe 21–27% of the people aged 65 and older are cognitively impaired (Ritchie et al., 2001; Millaán-Calenti et al., 2009) and about 32–54% have problems in performing activities of daily living (Agüero-Torres et al., 1998; Millán-Calenti et al., 2010).

Numerous studies have shown that cognitive decline and functional dependence are well correlated with mortality even when controlling for the effects of socio-demographic variables and health conditions (Guehne et al., 2006). Moreover, several cross-sectional studies have examined the interrelatedness of cognitive impairment and functional dependence on one another and have demonstrated a relationship between the two (Agüero-Torres et al., 2002; Black and Rush, 2002; Ishizaki et al., 2006). It was shown that older people with cognitive impairment are statistically more likely to be functionally dependent measured by ADL and IADL (Agüero-Torres et al., 2002; Black and Rush, 2002; Dodge et al., 2005; Ishizaki et al., 2006). Nevertheless, few studies have examined the effect of cognitive impairment on specific ADL or IADL tasks. They have shown that the association is most evident with ADL ‘‘bathing’’ and ‘‘toileting’’ and IADL ‘‘taking medications’’ and ‘‘preparing meals’’ (Artero et al., 2001; Agüero-Torres et al., 2002; Blaum et al., 2002; Dodge et al., 2005). Results from those studies suggested that cognition was differentially associated with ADL and IADL (Artero et al., 2001; Agüero-Torres et al., 2002; Black and Rush, 2002; Blaum et al., 2002; Dodge et al., 2005; Ishizaki et al., 2006).

Since poor cognitive function is thought to be a possible predictor for the first signs of functional dependence, demonstrating and understanding medical conditions and specific factors strongly associated with functional disability could help determine service needs and thus improve the quality of life of older people and decrease the burden on caregivers and society.

In previous studies, cognitive performance was not uniformly associated with limitations in each ADL and IADL, and our study of Spanish elderly population may give more insight into this subject.

Moreover, those studies did not investigate the influence of the severity of cognitive decline on functional dependence, including both ADL and IADL.

The aims of this study were to investigate the influence of cognitive status and severity of cognitive decline on the dependence on ADL and IADL, independently of socio-demographic variables and health conditions. A more comprehensive understanding of the effect of cognitive impairment on functional dependence also implied to examine each activity of daily living, including both basic and instrumental.

2. Subjects and methods

2.1. Selection and description of participants

Data for this study came from a representative sample (n = 600) of community-dwelling residents of Narón Council (A Coruña) who were aged 65 and older. They were randomly selected from the municipal register, using a random number table, and stratified by quinquennia of age and sex. In the sample, mean ± S.D. age was 75.1 ± 7.5 years, being 75.9 ± 8.0 years for women and 73.9 ± 6.7 years for men. The level of confidence was 95%, accuracy ± 4% and estimation for data losses 10%.

2.2. Procedure

The study protocol was approved by the Ethics Committee at the University of A Coruña. Participants were individually assessed in a Health Center or at home, in the case of people with mobility difficulties. Before the data collection, all participants were informed about the study and signed the corresponding Informed Consent.

2.3. Variables and instruments

The standardized questionnaire of Older Americans Resources and Services (OARS) (Pfeiffer, 1978) was used to assess the sociodemographic and general health status variables. Data related to general health status and biomedical parameters of the respondents were collected by a medical doctor (physician), or a trained nurse with extensive experience, in charge of the patients during the research. Medical histories (personal background and illnesses) were obtained from the subject anamneses collecting answers given by the patient him/herself or his/her relatives according to medical records. Anemia was defined as a hemoglobin level less than 13 g/dl for men and less than 12 g/dl for women (Fauci et al., 2008).

Cognitive status was assessed by a qualified clinical psychologist with extensive experience in cognitive assessment using the MMSE (Folstein et al., 1975). This questionnaire includes items assessing five cognitive domains with a maximum score of 30 corresponding to the best cognitive status and, a cut-off score of 23 or less indicating cognitive impairment. However it is widely accepted that this cut-off score must be varied according to age and educational level, particularly when assessing an elderly population (Weiss et al., 1995). The distribution of the MMSE score according to age and educational level was examined (Crum et al., 1993) and defined cut-off median scores according to those criteria. In this article, cognitive impairment is defined according to Crum's cut-off median scores. The score was treated as a continuous variable in multivariate analysis. The acceptance rate to undergo the MMSE test was 98.5%. Nine subjects with minimal level of consciousness were excluded from the random sample due to data losses as they were unable to be assessed by the MMSE test.

Functional status was measured using the ADL (Katz et al., 1963) and IADL (Lawton and Brody, 1969) scales. ADL included six activities: bathing, dressing, toileting, transferring, continence and feeding. The eight IADL included were as follows: using the telephone, shopping, preparing meals, housekeeping, doing the laundry, using transportation, taking medications and handling finances. Participants were asked if they had any difficulty performing each task without help from another person or special equipment. Individuals that were unable to perform any one of the activities were considered to be functionally incapacitated (ADL or IADL-dependent).

2.4. Statistical analysis

Analyses assessed the prevalence of cognitive and functional decline. Categorical differences were tested with x2-analysis. Spearman's correlation coefficient was used to analyze the association between quantitative variables. Age, gender, educational level and health conditions were considered potential

confounders and/or modifiers of the association between cognitive impairment and functional dependence and their effects were estimated by multivariate analysis. Logistic regression was then used to model the multivariate assessment of the effect of cognitive impairment on functional dependence, adjusting for the influence of socio-demographic variables and health conditions, from which the odds ratios (OR) along with their 95% confidence intervals (CI) were calculated. Statistical significance was set at $p < 0.05$. Statistical analyses were performed using the SPSS statistical package version 16.0.1. Box-plots were chosen to display differences in the distribution of different populations.

3. Results

When independently evaluated, 22.2% of the respondents presented with cognitive impairment, another 34.6% presented with functional dependence for at least one basic ADL and 55.3% dependence for at least one IADL. In search of the relationship between cognitive status and functional dependence, we found that 59.5% of the respondents presenting cognitive impairment were dependent for ADL, whereas an even larger proportion of the cognitively impaired (82.4%) were dependent for IADL (Table 1). Our results showed that cognitive performance, according to the MMSE, was positively correlated to functional ADL performance, according to Katz's scale (Spearman's correlation rho = 0.4, $p < 0.001$), and to functional IADL performance, according to Lawton's scale (Spearman's correlation rho = 0.5; $p < 0.001$). In other words, participants that were cognitively impaired were more likely to present with functional dependence on ADL (OR = 4.1; 95%CI = 2.7–6.1) and on IADL (OR = 5.7; 95%CI = 3.5–9.3) (Table 1).

Table 2 shows the results of multivariate logistic regression analyses that modeled functional dependence and the effects of cognitive level, age, gender, educational level and health conditions. The risk of functional dependence on ADL was increased in women compared to men (OR = 2.0; 95%CI = 1.3–3.1; $p < 0.05$) but was not affected by educational level (OR = 0.9; 95%CI = 0.6–1.3). The risk for developing IADL dependence increased with age (OR = 1.1; 95%CI = 1.1–1.2; $p < 0.001$) and in males (OR = 0.4; 95%CI = 0.3–0.6; $p < 0.001$). Individuals reporting history of cancer (OR = 4.8; 95%CI = 1.2–19.1; $p < 0.05$) or stroke (OR = 4.6; 95%CI = 2.2–9.6; $p < 0.05$) were at higher risk of developing ADL dependence and individuals reporting anemia (OR = 3.0; 95%CI = 1.2–7.5; $p < 0.05$) were at higher risk of developing IADL dependence. The MMSE score evaluating cognitive performance showed a significant negative correlation with increased risk for concomitant functional dependence on ADL (OR = 0.9; 95%CI = 0.8–0.9; $p < 0.001$) and IADL (OR = 0.9; 95%CI = 0.8–0.9; $p < 0.001$), even when controlling for the effects of all the sociodemographic variables and health conditions.

Table 1
Association of cognitive status and functional dependence on basic ADL and IADL.

Variable	Cognitive impairment, n (%)			
	Absent (-)	Present (+)	X^2 (p)	OR (95%CI)
ADL-dependence (-)	338 (73.5)	53 (40.5)	49.7 (<0.001)	4.1 (2.7–6.1)
ADL-dependence (+)	122 (26.5)	78 (59.5)		
IADL dependence (-)	253 (55.0)	23 (17.6)	57.4 (<0.001)	5.7 (3.5–9.3)
IADL dependence (+)	207 (45.0)	108 (82.4)		

Table 3 shows the results of the independent multivariate analysis of cognitive impairment with decreased ability at each activity on the ADL and IADL scales. The prevalence of ADL disabilities was on average decreased compared to IADL disabilities for the cognitively impaired. Those with cognitive impairment were likely to be disabled for some of the ADL tasks, including bathing (OR = 7.0; 95%CI = 3.5–14.3; $p < 0.05$) and toileting (OR = 17.9; 95%CI = 2.1–150.8; $p < 0.05$). Although the CIs were large (due to the small number of individuals with no cognitive impairment and dependence on ''toileting''), the association between cognitive impairment and the ability to go to the toilet was nevertheless significant. We also observed significant association between cognitive impairment and disability in some of the IADL tasks, including using the telephone (OR = 3.7; 95%CI = 1.6–8.6; $p < 0.05$), taking medications (OR = 3.0; 95%CI = 1.5–5.9; $p < 0.05$) and handling finances (OR = 3.1; 95%CI = 1.3–7.4; p

< 0.05). Notably, these associations survived adjustment for age, gender, and health conditions (cancer and stroke for ADL; anemia for IADL), variables reporting relative risk for functional dependence according to Table 2. The estimates and significance levels virtually did not change, except that the coefficient for bathing decreases from 7.0 to 4.0 and the coefficient for toileting increases from 17.9 to 24.5 indicating that part of the association with cognitive impairment is due to compromised function.

Table 2
Independent factors associated with basic ADL and IADL, OR (95%CI).

	ADL dependence	IADL dependence
MMSE score[a]	0.9* (0.8–0.9)	0.9* (0.8–0.9)
Age	1.0[y] (1.0–1.1)	1.1* (1.1–1.2)
Gender (male vs. female)	2.0[y] (1.3–3.1)	0.4* (0.3–0.6)
Educational level (<5 vs. ≥ 5 years)	0.9 (0.6–1.3)	0.8 (0.5–1.1)
Health conditions (no vs. yes)		
Cancer	4.8[y] (1.2–19.1)	2.9 (0.5–17.2)
Anemia	1.1 (0.5–2.4)	3.0[y] (1.2–7.5)
Heart failure	1.4 (0.8–2.3)	1.7 (1.0–2.9)
Diabetes	0.9 (0.5–1.5)	1.4 (0.8–2.5)
Stroke	4.6* (2.2–9.6)	1.8 (0.8–4.0)
Visual deficit	1.0 (0.5–2.0)	1.5 (0.7–3.1)
Auditory deficit	1.6 (0.9–2.8)	1.2 (0.7–2.2)

[a] *Mini-Mental State Examination.*
** Significant at p < 0.001.*
[y] *Significant at p < 0.05.*

Fig. 1 shows the distribution of the MMSE score according to the dependence on ADL and IADL of the study participants. We observed that the average MMSE score for the functionally dependent respondents on ADL (20.6 ± 7.1 points; median = 23 points) and IADL (21.9 ± 6.5 points; median = 24 points) was indicative of an impaired cognitive status. The average MMSE score also denoted more severe cognitive impairment for individuals dependent on ADL than on IADL. There appeared to be three levels of functional ability associated with cognitive status. The first level corresponded to MMSE scores of 26 and greater (out of 30) and included individuals mainly dependent on instrumental activities. The second level corresponded to MMSE scores between 19 and 26 (out of 30) and included a mixture of dependence on IADL and on ADL. The third level corresponded to MMSE scores of less than 19 (out of 30) and included mostly dependence on basic activities.

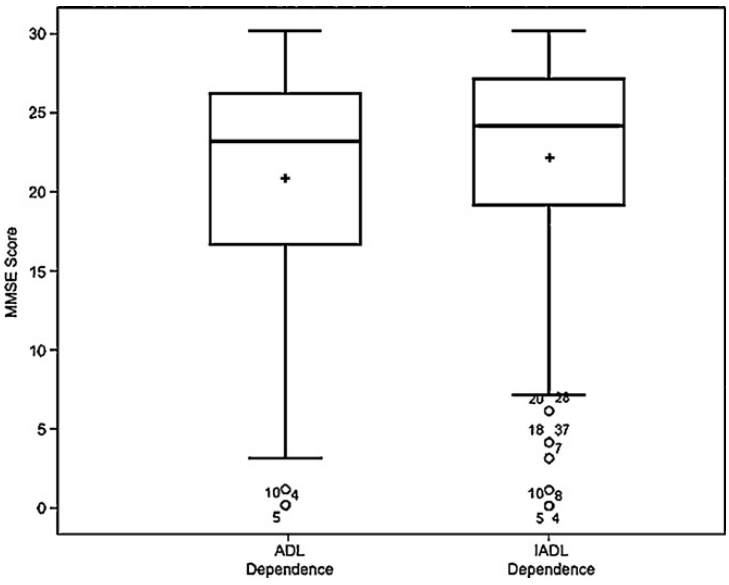

Fig. 1. Box-plot distribution of the MMSE score according to the dependence on basic ADL and IADL in the sample. (Note: '+' indicates the mean position.)

Table 3
Association of cognitive impairment and each activity of the ADL and IADL scales independently, n (%).

	Cognitive impairment		OR (95%CI)	OR (95%CI)
	(-)	(+)		
ADL dependence				
Bathing	27 (5.9)	59 (45.0)	7.0* (3.5–14.3)	4.0* (1.8–8.7)
Dressing	13 (2.8)	39 (29.8)	0.8 (0.3–2.6)	1.0 (0.3–3.3)
Toileting	2 (0.4)	32 (24.4)	17.9* (2.1–150.8)	4.5* (2.7–218.7)
Transferring	6 (1.3)	29 (22.1)	0.6 (0.1–3.7)	0.4 (0.1–2.6)
Continence	108 (23.5)	59 (45.0)	1.0 (0.6–1.8)	0.8 (0.5–1.5)
Feeding	0 (0)	8 (6.1)	>1–	>1–
IADL dependence				
Using the telephone	12 (2.6)	42 (32.1)	3.7* (1.6–8.6)	3.5* (1.4–8.6)
Shopping	134 (29.1)	99 (75.6)	1.9 (1.0–3.7)	1.5 (0.8–3.1)
Preparing meals	132 (28.7)	95 (72.5)	1.3 (0.6–2.7)	1.5 (0.7–3.3)
Housekeeping	55 (12.0)	67 (51.1)	1.0 (0.5–2.1)	1.3 (0.6–2.7)
Doing the laundry	91 (19.8)	80 (61.1)	1.3 (0.6–2.7)	1.8 (0.9–3.8)
Using transportation	63 (13.7)	72 (55.0)	1.4 (0.7–2.7)	0.9 (0.4–1.8)
Taking medications	34 (7.4)	70 (53.4)	3.0* (1.5–5.9)	2.8* (1.4–5.6)
Handling finances	13 (2.8)	53 (40.5)	3.1* (1.3–7.4)	2.7* (1.1–6.5)

* Significant at $p < 0.05$.

4. Discussion

We have presented strong evidence of differential association between cognitive status and functional dependence on ADL and IADL. In agreement with previous studies (Agüero-Torres et al., 2002; Black and Rush, 2002; Ishizaki et al., 2006) we observed a positive correlation between cognitive and functional performance at ADL and IADL, compatible with the hypothesis that cognitive decline affects functional dependence in the elderly population. Cognitively impaired participants were four times more likely to present functional dependence on ADL and six times more likely to present dependence on IADL, in agreement with other results (Ishizaki et al., 2006). Since ADL and IADL scales are not sensitive to functional losses resulting from cognitive deficits (Spector, 1997) the association reported here between cognitive impairment and functional dependence in older people is even more informative.

Certain socio-demographic factors (age and gender) and health conditions (cancer, stroke and anemia) were associated with functional dependence on ADL and/or IADL in the elderly population in our study. Older women were more likely dependent in ADL than men of the same age, independently of education and health conditions, consistent with other previous findings (Von Strauss et al., 2003). Given that household activities are commonly associated with traditional gender roles (Allen et al., 1993), the finding that older men were more likely to receive help when they attempted IADL than women was supportive of other studies (Fleishman et al., 2002). Previous studies investigating the impact of health conditions on functional limitations in older adults have shown that cerebrovascular disease (i.e., stroke) is the best predictor for functional limitations (Guccione et al., 1994; Dunlop et al., 2002). Even after adjusting for all the socio-demographic and health conditions variables by a model of logistic regression, cognitive status was strongly associated with functional dependence on both ADL and IADL, in agreement with suggestions in the literature (Black and Rush, 2002; Dodge et al., 2005).

The implications of our findings for medical care of older people are great. Cognitive impairment is a marker of increased risk of functional dependence on ADL and IADL independently or when associated with acute events such as stroke and slowly progressive diseases such as cancer and anemia. As there is potential for preventing and managing cognitive impairment and health conditions, regular and careful assessment of those elderly people at early stages of cognitive impairment and comorbidities is encouraged to prevent functional disability.

As reported previously (Artero et al., 2001; Agüero-Torres et al., 2002; Blaum et al., 2002; Dodge et al., 2005; Mariani et al., 2008) the association of cognition with functional dependency can be more specific for each particular ADL and IADL tasks. Assessment of the effect of cognitive impairment on multivariate ADL tasks showed that the association is more evident with ‘‘bathing’’ and ‘‘toileting’’ in our study. The association with the ADL task ‘‘bathing’’ is in agreement with previous findings (Agüero-Torres et al., 2002; Black and Rush, 2002; Blaum et al., 2002; Dodge et al., 2005; Ishizaki et al., 2006). However cognitive performance was not uniformly associated with limitation in ‘‘toileting’’. A study (Agüero-Torres et al., 2002) reported association with ‘‘dressing’’ and another one (Dodge et al., 2005)

observed a larger impact of cognitive impairment on the ADL task ‘‘feeding’’. Nevertheless, other authors (Artero et al., 2001) examined four domains of cognitive function (attention, memory, language, and visuospatial performances) and found that deficit in any of these functions reduced the ability to execute everyday activities, particularly the ability to use the toilet. With regard to IADL tasks, the ability to use the telephone, take medications and handle finances are activities most strongly associated with cognitive impairment in our study. In agreement with previous findings, ‘‘taking medications’’ and ‘‘handling finances’’ are the functions most interrelated to cognitive impairment (Artero et al., 2001; Blaum et al., 2002). On the other hand, some investigations found that activities related to housework (‘‘housekeeping’’ and ‘‘shopping’’) required a good cognitive level (Blaum et al., 2002; Mariani et al., 2008).

The association of cognitive impairment was more evident with the IADL tasks ‘‘shopping’’ and ‘‘taking medications’’ (Mariani et al., 2008). It is evident that our results are in agreement with what has been previously reported but with some notable differences. Receiving help with ADL and IADL tasks may reflect socio-cultural factors such as expectations concerning when it is appropriate to request help with these tasks. Notably, the population selected for our study was limited to respondents from Spain, with a different cultural approach to aging. The differences observed between our study and previous studies may also be due to ethnic and economic factors affecting each study (Black and Rush, 2002; Dodge et al.,

2005). Other factors that may have also influenced the results include depressive symptoms at the time the questionnaire was completed and physical abilities, because of their influence on respondents’ self-motivation for carrying out activities (Covinsky et al., 1999; Marengoni et al., 2004). Although our analyses do not address these other dimensions, they will be the object of our future studies. Another complementary possible explanation for the differences observed may come from the methodology used in this study. When considering the association of cognition with functional disability on each particular ADL and IADL tasks from the Katz and Lawton scales, one must consider the impact on the validity of the instrument and the potential loss of precision. Moreover, ADL and IADL items form a hierarchy, with stratification and clustering, and threshold varying across items may produce biased estimates (Thomas et al., 1998).

Our study suggested that cognitive impairment had a strong effect on the dependence on the execution of everyday activities, basic and instrumental, independently of age, gender, educational level and health conditions. However cognitive impairment was not uniformly associated with specific ADL and IADL tasks, some tasks being more affected. Our study also showed evidence that the degree in cognitive decline affected functional disability in ADL and IADL in a different way, as was suggested in another study (Njegovan et al., 2001). Our results agreed with model of Lawton (1972) that there is a tendency for IADL to be lost at higher cognitive levels compared with ADL. Therefore, a hierarchy exists in the loss of capacity to perform activities of daily living as the cognitive impairment progresses. The functional loss of more complex tasks, the IADL, becomes evident in stages of milder cognitive decline whereas the functional loss of simpler task, the ADL, appears when the cognitive impairment is more advanced. That is, older persons with progressive cognitive decline lost the ability to perform these tasks in the opposite order to which they acquired them in the childhood (Katz et al., 1963). Thus, persons who are unable to execute any ADL task should be unable to execute any other IADL task independently.

Although the cross-sectional nature of the study limits our discussion on the direction of associations, this study has a large sample size, good response rate, valid measurement instruments and it advances knowledge on cognitive status and functional wellbeing of the elderly in a cultural context which predominates widely in the world.

5. Conclusion

In conclusion, our findings suggest that good cognitive status is an important influence on the functional wellbeing in elderly populations. Thus, cognitive scores can be used to forecast service needs and to develop intervention programs to prepare for the possible onset of ADL and IADL limitations.

Conflict of interest statement

None

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