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Cognitive performance and frailty in older adults clients of a private health care plan

ABSTRACT

OBJECTIVE: To investigate the association between frailty syndrome and cognitive performance in the older adults and the effect of schooling and age on this association.

METHODS: Data on frailty in older adults from Phase 1 of the FIBRA-RJ Study were analyzed, relating to 737 customers of a private health care provider, aged 65 and over, living in Rio de Janeiro, Southeastern Brazil, between January 2009 and January 2010. Data on socioeconomic and demographic characteristics, medical conditions and functional capacity were collected. Cognitive performance was assessed using the Mini-Mental State Examination (MMSE). Individuals who exhibited three or more of the following features were considered to be frail: unintentional weight loss (≥ 4.5 kg in the last year); feeling self-reported exhaustion, low grip strength, low physical activity level and slowness. The association between frailty and cognitive performance was evaluated using multivariate logistic regression, with adjustment for medical conditions, activities of daily living and socioeconomic variables. We evaluated the age and schooling as possible effect modifiers in this association.

RESULTS: The frail subjects had a higher prevalence of low cognitive performance, compared to not frail or pre-frail, in the three age groups studied (65-74; 75-84; ≥ 85 years), $p < 0.001$. After adjustment, the association between frailty and cognitive performance was found among older adults individuals aged 75 and older, with an $OR_{adj} = 2.78$ (95%CI 1.23;6.27) for those aged 75 to 84 and $OR_{adj} = 15.62$ (95%CI 2.20;110.99) for 85 and older. The age variable was an effect modifier in the association between frailty and cognitive performance, χ^2 (5) = 806.97, $p < 0.0001$; the same was not the case with schooling.

CONCLUSIONS: Frailty syndrome is associated with cognitive performance in the aging. Age proved to be an effect modifier in this association. The oldest patients showed a more significant association between the two phenomena.

DESCRIPTORS: Aged. Frail Elderly. Cognition. Socioeconomic Factors. Health Maintenance Organizations. Cross-Sectional Studies.

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INTRODUCTION

From the 1940s onwards, the age composition of the Brazilian underwent changes and, more significantly, after the 1960s the number of older adults increased considerably.[a,b] There are 21 million individuals aged 60 and over in the country (11.1% of the total). In the Southeast, the number of older individuals is almost 10 million (12.4% of the total for the region) and there are more than two million (14.9%) in the state of Rio de Janeiro.[a] The *Instituto Brasileiro de Geografia e Estatística* (IBGE – Brazilian Institute of Geography and Statistics) revised population projections stating significant increases in the number of individuals ≥ 60 in 2008. This group will go from 13.9 million in 2000 to 28.3 million in 2020, reaching 64 million in 2050.[a]

Mean life expectancy increases year on year due to better control of environmental risks and to improvements in medical interventions. However, many of the older adults who survive have to bear the load of chronic disease, need more frequent medical attention, consume more medicines and undergo more medical tests and hospitalizations.[2] Moreover, older adults frequently suffer from forgetfulness and other cognitive alterations. Studies show that ageing, in addition to alterations in memory, is also related to declines in executive functions and in language.[10,17]

Studies associate advanced age and low levels of schooling to low cognitive performance. The more aged and those with low levels of schooling have a higher prevalence of dementia.[8,15] Studies of performance in neuropsychological tests state that low schooling interferes with the test scores.[1,12]

Cognitive disorders in older adults are often associated with frailty. Frailty syndrome has a multi-systemic character and reduces the organism's capacity to respond appropriately to adverse events when exposed to stressors. Frail individuals benefit less from therapeutic interventions, the defence system is inefficient and interactions, independence and quality of life are negatively affected. This condition results in vulnerability to adverse health outcomes, with high rates of mortality, fractures and falls and increases in hospitalizations and re-hospitalizations, incapacity, among others.[7] As there are a great number of older individuals in these conditions, the health care costs of the older population become high.[23]

Changes in cognitive functions, together with social, economic, demographic and health variables may be risk factors for frailty.[16,19] Raji et al[19] examined the association between cognition and risk of becoming frail within 10 years in 942 elderly individuals, who were not frail at the baseline. They confirmed the hypothesis that participants with poor cognitive functioning, with scores below 21 in the Mini Mental State Exam (MMSE),[5] had a greater risk of becoming frail than those with high cognitive functioning (score of 21 or over in the MMSE). Other studies[20,24] examined frailty syndrome as a risk factor in cognitive performance changes. Samper-Ternent et al[20] studied 1,370 individuals aged 65 and over in five American states (Hispanic Established Population for the Epidemiological Study of the Elderly), with cognitive performance ≥ 21 points in the MMSE[5] and concluded that being classified as frail is a significant risk factor in a decreasing MMSE score after 10 years.

Yassuda et al[24] carried out a study of 384 older individuals resident in Sao Paulo, SP, Southeastern Brazil. The objective was to evaluate the association between the criteria of Fried et al[6] in diagnosing frailty and cognitive performance. The results showed that being frail was associated with poor cognitive performance, but the authors considered the possibility that the phenomena occurred simultaneously. The first study did not investigate the role of age and schooling in the association in question. In a second study with the same sample, Macuco et al[13] showed that the MMSE score was influenced by age, education, household income and being frail. Frail older elderly individuals performed significantly worse in the MMSE.

This study aimed to analyze the association between frailty syndrome and cognitive performance in older individuals and the influence of schooling and age on this association.

METHODS

The data came from Stage 1 of the *Estudo da Fragilidade em Idosos Brasileiros* (Frailty in Brazilian Older People Study), Rio de Janeiro section (FIBRA-RJ), one of the research centers of the FIBRA Network. There were 847 individuals aged 65 and over who participated in this study. They were clients of a private health care plan, resident in the north of Rio de Janeiro, RJ, Southeastern Brazil, between January 2009 and January 2010.

To select the sample, stratification was carried out for sex versus age group of the clients registered in the private health care plan's database. The age groups were defined as: 65 to 74; 75 to 84; 85 to 94; and 95 and over. In this last age group, there was no selection

[a] Instituto Brasileiro de Geografia e Estatística. Indicadores sociodemográficos e de saúde no Brasil 2009. Rio de Janeiro; 2009. (Estudos e Pesquisas. Informações Demográficas e Socioeconômicas, 25).
[b] Instituto Brasileiro de Geografia e Estatística. Projeção da população do Brasil por sexo e idade para o período 1980-2050: revisão 2008. Rio de Janeiro; 2009. (Estudos e Pesquisas. Informações Demográficas e Socioeconômicas, 24).

for the strata of men and women (all the individuals were included); the likelihood of selection was the same in the other strata. It was necessary to use an inverse random sampling strategy to attain the representative sample size for each stratum, ensured by replacing lost individuals due to no response, refusal and not being with the area of the study (living in a care home, change of direction or death occurring before the start of the study). The sample size was calculated so that the coefficient of variation of the different estimates for the variables in question in each stratum was 15% for estimates of proportion around 0.07, with 95% confidence interval. A factor of expansion was attributed to each sample unit, defined from a basic weight, and a factor of correction that combined the adjusts for non-response and for the situation including all of participants who died during the study and those who refused to take part.

The sample interviewed for the FIBRA-RJ consisted of 847 individuals, representing an expanded sample of 9,197 units of analysis. There were 737 individuals included in the analysis, after excluding 110 (12.9%) who did not complete the MMSE (12 individuals, 1.4%), for severe sensory deficit (52 individuals, 6.1%) and those whose walking speed could not be measured (27 individuals, 3.2%) as they were in a wheelchair or bedridden. A weighted and expanded sample of 8,085.65 was obtained considering the weight of each unit and of the exclusions.

The data were collected in face-to-face interviews, lasting approximately 60 min.

Cognitive performance was assessed using the MMSE.[3,5] The cutoff points were 18/19 (poor cognitive performance/normal cognitive performance) for illiterate subjects and 24/25 for those with one or more years of studies.[12]

The five items proposed by Fried et al[6] were considered: unintentional weight loss; feeling of exhaustion; weak grip; low levels of physical activity and slow walking pace. Older individuals with three or more of the above characteristics were deemed frail. Older adults with one or two characteristics were deemed pre-frail.

Unintentional weight loss was assessed using self-reporting. Subjects who had unintentionally lost > 4.5 kg or > 5% of body weight within the last year or those with a body mass index < 18.5 kg/m were considered positive.[2,6]

Feeling exhausted was assessed using two items from the Center of Epidemiological Study Center Scale (CES-D):[18] "Do you feel like you have to make an effort to take care of your normal tasks?" and "Do you feel like you can't get going?". For this item of frailty, subjects who answered "Yes" to at least one of these questions were deemed positive.[6]

Grip strength was assessed using a hand dynamometer (JAMAR Modelo J00105) with the dominant arm and asking the participant to squeeze as hard as possible, three times. Subjects in the first quintile after adjusting for sex and body mass index[6] were considered positive in this item of frailty.

Levels of physical activity were assessed using the Minnesota Leisure Time,[22] instrument that evaluates the physical activity carried out by the subject and the estimated calories burned (per minute). The calculation takes into consideration the individual's body weight and the figure for the metabolic equivalent (MET; 1 MET = 0.0175 kcal x kg-1 x min-1) needed to carry out the activity. The quantity of MET needed for each activity is already known.[22] The subjects in the first quintile were considered positive for this item.[6]

Slow walking pace was evaluated using a chronometer to measure the time needed to walk 4.5m. Subjects in the first quintile after adjusting for height were considered positive.[6]

Socio-economic and demographic characteristics included gender, age, schooling (in years of study), marital status and personal income (in minimum wages). Medical conditions were assessed using the following questions: "In the last year, have you been told by a doctor that you have any of the following health problems: heart disease such as angina, myocardial infarction or heart attack, hypertension, vascular stroke/stroke/cerebral ischemia, diabetes mellitus, arthritis or rheumatism, or depression?". The following question was asked in order to assess urinary and fecal incontinence: "In the last 12 months have you suffered from any of these problems?" Functional capacity was evaluated using the instrumental (IADL)[11] and basic (BADL)[9] activities of daily living scales. Those who declared themselves capable of carrying out all of the basic and instrumental activities without any help were classified as independent, whereas those who reported themselves incapable of performing one or more of the basic and/or instrumental activities were deemed to be dependent.

The weightings for each individual were considered in all of the analyses, as this was a weighted, expanded sample. The cognitive performance variable (MMSE) was treated as dichotomous,[12] as was being frail (Not frail/Pre-frail and Frail). The association between frailty and the co-variables and cognitive performance was assessed. Pearson's Chi-square test was used for bivariate analysis. The Mantel Haenszel interaction test was used to verify whether the variables of age and schooling acted as effect modifiers on the association between frailty and poor cognitive performance. Next, multivariate logistic regression was carried out to assess the effect of being frail on cognitive performance, after adjusting for confounding variables. Raw and adjusted odds ratios and their respective 95% confidence

intervals were calculated. The co-variables that showed simple association with the outcome ($p \leq 0.25$) were included in the models as confounding variables. These analyses were stratified by age group (65 to 74, 75 to 84 and 85 and over). The data were analyzed using the SPSS statistics program version 18.

The study was approved by the Research Ethics Committee of the *Hospital Universitário Pedro Ernesto* (Process nº 1850-CEP/HUPE, 2007). All participants signed a consent form.

RESULTS

There 737 older adults aged between 65 and 101 years (mean 76.7 years) who were analyzed. The prevalence of frailty was 9.2%; 46.5% of the individuals were deemed to be pre-frail. The prevalence of poor cognitive performance was 30.2%. Most individuals were female (66.9%) and were aged between 65 and 84 (40.9% from 65 to 74 and 46.4% from 75 to 84), and 0.6% were aged over 95. The percentage of individuals with nine or more years of study was high compared with national patterns: 31.8% had between nine and 12 years of study and 28.4% had 13 or more. Individuals with between five and eight years of schooling made up 20.3% of the total; two to four years, 16.5%; and zero to one year, 2.9%. Most older adults in this sample were married or cohabiting (44.0%) and a significant percentage were widowed (37.7%). The most common income was between 2.1 and five minimum wages (34.5%) and was similar in all other income bands: 27.5% of individuals received over eight minimum wages; 21.7% between 5.1 and eight; and 16.4% between zero and two minimum wages. The majority (87.4%) received support from a network of social relationships and a large part of the sample had some type of functional dependency (56.5%). The following rates of prevalence of morbidities were found: 64.6% for hypertension, 34.9% for arthritis or osteoarthritis, 22.2% diabetes mellitus, 21.4% for urinary incontinence, 13.8% for coronary artery disease, 13.4% for depression, 5.6% for fecal incontinence and 4.4% for cerebrovascular accident (CVA).

There was a statistically significant difference in cognitive performance with regards all of the socio-economic and demographic variables. The highest prevalence of poor cognitive performance was observed in females, those of advanced age, with low levels of schooling and on a low income (Table 1).

Table 1. Distribution of socio-demographic characteristics, MMSE score, IADL and BADL for the total sample and grouped by cognitive performance. FIBRA/RJ Study. Rio de Janeiro, RJ, Southeastern Brazil, 2009. (N = 737)

Variable	Cognitive performance					
	Total sample		Normal		Decreased	
	n	%	n	%	n	%
Gender						
Male	220	33.1	165	75.5	55	24.5
Female	517	66.9	350	67.0	167	33.0
Age group (years)						
65 to 74	318	40.9	261	82.2	57	17.8
75 to 84	325	46.4	215	66.3	110	33.7
85 to 94	83	12.1	37	44.3	46	55.7
≥ 95	11	0.6	2	13.0	9	87.0
Personal income (minimum wages)						
0 to 2	118	16.4	58	49.0	60	51.0
2.1 to 5	244	34.5	163	66.4	81	33.6
5.1 to 8	153	21.7	121	78.9	32	21.1
> 8.1	188	27.5	154	82.0	34	18.0
BADL						
Independent	605	82.2	432	71.3	173	28.7
Dependent in 1 activity	123	16.7	80	65.2	43	34.8
Dependent in 2 or more activities	9	1.2	3	32.0	6	67.0
Mean of total years of schooling (SD)	10.11	5.08	11.17	4.78	7.66	4.92
Mean IADL score (SD)	18.80	2.80	19.33	2.27	17.56	3.46
Mean MMSE (SD)	25.55	3.28	27.29	1.63	21.54	2.54

N (%): number of individuals in the non-weighted sample (percentage weighted by sample weight)
MMES: Total score in the mini mental state exam; IADL: Score for instrumental activities of daily living, with 21 being the score for total independence; DADL: Basic activities of daily living; SD: Standard deviation

Higher prevalence of poor cognitive performance was found in older adults who had suffered CVA at some point in their lives, those who were depressed, those with arthritis or osteoarthritis, those with urinary incontinence and those who were functionally dependent. There was a statistically significant difference with regards having suffered from a CVA, depression, arthritis or osteoarthritis, urinary incontinence and being functionally dependent. Having someone to care for them if necessary, having coronary artery disease, hypertension, diabetes mellitus, suffering from or having suffered from cancer and fecal incontinence did not any statistically significant difference (Table 2).

Age, according to the different age groups, acted as an effect modifier (Mantel Haenszel, $\chi^2(5) = 806.97$, $p < 0.0001$) for the association between frailty and poor cognitive performance. No modification of effect was observed between frailty and poor cognitive performance according to different levels of schooling (from zero to eight years and more than eight years).

After adjusting for the physical morbidity variables (CVA, depression, urinary incontinence, arthritis or osteoarthritis) and the activities of daily life and socio-economic and demographic variables, which remained in the final model, the association between frailty and poor cognitive performance remained in those older individuals aged 75 and over (OR = 2.78; 95%CI 1.23;6.27) those aged 75 to 84 and OR = 15.62; 95%CI 2.20;110.99 for those 85 and over (Table 3).

Table 2. Expanded Prevalence (%) of poor cognitive performance, according to social support, medical conditions and functional capacity, in the study population. FIBRA-RJ Study. Rio de Janeiro, RJ, Southeastern Brazil, 2012. (N = 737)

Variable	Poor cognitive performance	
	%	P
Have someone to care for them if necessary		0.836
No	31.1	
Yes	30.0	
Coronary artery disease		0.367
No	29.5	
Yes	34.1	
Hypertension		0.984
No	30.1	
Yes	30.2	
CVA Cerebral		0.024
No	29.3	
Yes	48.7	
Diabetes mellitus		0.264
No	31.2	
Yes	26.6	
Depression		0.118
No	29.1	
Yes	36.9	
Arthritis or Osteoarthritis		0.132
No	28.3	
Yes	33.7	
Cancer		0.750
No	30.0	
Yes	32.6	
Urinary incontinence		0.026
No	28.2	
Yes	37.5	
Fecal incontinence		0.835
No	30.1	
Yes	31.6	
Functional capacity		< 0.001
Independent	23.3	
Dependent	35.4	

CVA: cerebrovascular accident

DISCUSSION

The results of this study confirm the association between frailty and poor cognitive performance found in other studies[4,13,20] and gives a result previously unreported in the literature on the topic: the role of age as an effect modifier in this association.

Although comparisons between these results and others described previously[4,20] are limited due to difference in sample design and population, they point in the same direction, i.e., they reinforce the evidence of the association between frailty and poor cognitive performance. Samper-Ternent et al[20] found lower MMSE scores among the frail compared with those who were not frail. The risk of a frail older adult obtaining a MMSE score below 21 was 1.3 times higher than for a non-frail counterpart after ten years of follow up and adjusting for all of the co-variables (gender, age group, schooling, marital status and medical conditions). Another study with 820 subjects, assessed over three years, found that the risk of developing Alzheimer's was 2.5 times greater among frail individuals.[4] Studies in Brazil have shown poorer cognitive performance in frail older adults than those who were pre-frail or normal.[24] In addition to being frail, increased age, low levels of schooling and low household income were associated with worse scores for overall cognitive performance, for temporal orientation and for short-term memory.[13] None of these studies assessed the role played by age an effect modifier on the association between frailty and poor cognitive performance. This variable was tested only as a confounding factor with regards frailty and cognition.

Table 3. Expanded Prevalence (%) of poor cognitive performance, raw and adjusted odds ratios (OR) and their respective 95% confidence intervals (CI95%) according to frailty status, stratified by age group. FIBRA-RJ Study. Rio de Janeiro, RJ, Southeastern Brazil, 2012. (N = 737)

Frailty status	Poor cognitive performance										
	%	Raw OR	95%CI	Model 1 OR_{adj}	95%CI	Model 2 OR_{adj}	95%CI	Model 3 OR_{adj}	95%CI	Model 4 OR_{adj}	95%CI
65 to 74 year old age group											
Non frail/ Pre-frail	17.5	1		1		1		1		1	
Frail	24.0	1.48	0.38;5.70	1.43	0.35;5.81	1.36	0.35;5.26	0.72	0.21;2.48	0.65	0.19;2.24
75 to 84 year old age group (n = 325)											
Non frail/ Pre-frail	31.3	1		1		1		1		1	
Frail	55.0	2.68	1.29;5.53	2.47	1.16;5.28	2.60	1.23;5.48	2.59	1.19;5.66	2.78	1.23;6.27
≥ 85 years old age group (n = 94)											
Non frail/ Pre-frail	48.4	1		1		1		1		1	
Frail	85.5	6.39	1.82;22.42	6.31	1.76;22.62	5.49	1.51;19.90	12.07	2.49;58.53	15.62	2.20;110.99

Model 1: Adjusted for CVA, Depression, urinary incontinence, arthritis and osteoarthritis
Model 2: Adjusted for activities of daily living
Model 3: Adjusted for gender, schooling, marital status and personal income
Model 4: Adjusted for CVA, depression, urinary incontinence, arthritis and osteoarthritis, activities of daily living, gender, schooling, marital status and personal income

Researchers in the area support the idea of adding loss of cognitive function as one of the components of frailty, although this is a controversial issue. For now, it is recommended that frail patients undergo assessment of cognitive functions and that frailty be investigated in those with loss of cognitive function.[20]

The primary finding of this study is the evidence of the role age plays in the association in question. Multivariate analysis, stratified by age group (65 to 74, 75 to 84 and 85 and over) is adjusted for physical morbidities and socio-economic and demographic variables, showing that this association persists in those aged over 75 and that the chance of a frail older adult having poor cognitive performance is around seven times greater in those aged 85 and over than in those aged between 75 and 84. The test for interaction between frailty and age was statistically significant ($p < 0.0001$).

Frailty was more prevalent in older age groups.[6] Physiological changes in the brain due to increased age, which may lead to significant cognitive alterations, are also described.[14] Thus, it is possible to understand in what way age may act as an effect modifier in the association between frailty and cognitive performance.

The hypothesis that schooling would be an effect modifier in the association in question was not confirmed in the analyses. The results of other studies on performance in neuro-psychological tests state that low levels of schooling can interfere with test scores.[1,12]

Despite there being no relationship between schooling and frailty established in the literature, it is plausible that the level of education acts as an effect modifier in the association between frailty and cognitive performance by mechanisms such as cognitive reserve,[21] in which increased levels of schooling are viewed as protection against genitive damage in older individuals. However, no other study investigating the role of schooling in the association in question was found.

The main limitations of this study were the use of only one screening test to assess cognition, when the ideal would be to use a short battery of neuro-psychological tests. The MMSE gives an overall assessment of cognition; though it would be interesting to consider the different cognitive functions (memory, executive function, attention, language and others) separately in the association between frailty and cognitive performance. Moreover, a more complete cognitive assessment would give more precise data on the prevalence of poor cognitive performance. Another limitation lies in the cross-sectional design, which does not allow the order in which the phenomenon occur to be known, and may lead to reverse causality. This possibility should not be ruled out, considering that the phenomena in question work both ways. A longitudinal study of older adults without cognitive loss would allow its incidence in frail and non-frail older adults to be assessed and enable the calculation of relative risk of this decline associated with frailty.

The association between frailty and cognition in the ageing remains a topic little studied nationally and internationally. This investigation was pioneering in assessing the role of age and schooling as potential effect modifiers in the association in question. Frailty decreases cognitive performance in individuals aged 75 and over, possibly due to mechanisms such as decreases in cognitive and physiological reserves suffered by those aged over 85. Such findings indicate the need for specialized assessments of the population aged 74 and over and who are frail. Longitudinal studies of the Brazilian population need to be carried out to assess the role frailty plays in changes in cognitive performance in the older adults over time. The use of other neuro-psychological tests might contribute to more specific assessments of cognitive performance and all the start of the decline to be identified, which is fundamental to determining incidence.

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