Relationship Between Memory Performance and Executive Functioning with Daily Living Functionality in Adults in the City of Medellín: An Observational Study

Diana Cristina Lopez Giraldo[1], Daniel Londoño Guzmán[2]*, Ana Milena Gaviria Gomez[3], David Andres Montoya Arenas[4], Maria Estefanía Otálvaro Arcila[5] and Cecilia Maria Diaz Soto[6]

[1]*Research group: Observatory of public health, Universidad Ces-Medellín, Colombia*

[2]*University of San Buenaventura-Medellín, Colombia*

[3]*Research group: Psychology and Neuroscience. María Cano University Foundation; research group Psyche & Society, University of San Buenaventura-Medellín, Colombia*

[4]*Research group: Psychology and Neurosciences. Universidad Pontificia Bolivariana, research group: ECCO, University of San Buenaventura-Medellín, Colombia*

[5]*Research group: Psychology and Neuroscience, University of San Buenaventura-Medellín, Colombia*

[6]*Research group: Psychology and Neuroscience, University of San Buenaventura-Medellín, Colombia*

Submission: September 07, 2023; **Published:** September 13, 2023

*Corresponding author: Daniel Londoño Guzmán, University of San Buenaventura-Medellín, Colombia

Abstract

Introduction: The neuropathological processes in the elderly lead to changes in their independence, therefore, in their functionality. The objective of the present study was to analyze the relationship between individual characteristics, clinical history, memory performance and executive functioning, with the functionality of daily life.

Subjects and Methods: Data from the Neuronorma-Co research project, obtained from January 2016 to January 2017, were analyzed. The database had data from clinical records and neuropsychological tests of 126 adults from the city of Medellín, between 47 and 94 years of age. The correlation between the score obtained in the Tower of London, the learning and memory task with controlled coding of Grober and Buschke, the Modified Lawton scale and the Geriatric Depression Scale was analyzed.

Result: A relationship of functionality was found with age, years of schooling, marital status, ophthalmological, neurological and cardiovascular history, risk of depression, memory and executive functions such as sequencing and problem solving.

Conclusion: The variables with the greatest impact on functionality are related to problem solving and cognitive reserve.

Keywords: Cognitive decline; Aging; Function; Executive functions; Memory

Introduction

The population is aging at an unprecedented rate in the history of humanity [1], increasing the demand for medical care for elderly patients [2], which translates into a challenge for these professionals due to the characteristics of this population: changes in functionality and cognition, semiology typical of neurodegenerative diseases associated with pathological aging and main causes of disability in older adults. Currently, it is estimated that 15% of the world's population or about one billion people live with one or more conditions of disability. More than 46 per cent of older persons (aged 60 and older) have disabilities and more than 250 million older persons experience moderate to severe disabilities [3], implying enormous economic expenditure globally [4].

Pathological aging is accompanied by morphological, functional and psychological changes that entail changes that imply loss of autonomy, therefore, increasing the vulnerability

of the individual [1]. In the nervous system, neuropathological changes include amyloid deposits, abnormal Tau protein deposits in neurofibrillary somas-tangles or dystrophic dendrites, neurites, decreased volume in the cerebral cortex and gray matter [5], which have been associated with changes at the cognitive level, such as progressive loss of the ability to register information [6] and decreased planning capacity, sequencing and divided attention [7].

With the progress of pathological aging, the other functions (gnosis, praxias and language) also deteriorate, however, memory and executive functioning are the most sensitive to presenting alteration and in which deterioration can first be identified [8]. As humans age, the decline in cognitive functions described above leads to a loss of independence in older adults, in whom the risk of dementia is more frequent [9]. Functionality allows people to live independently, which translates into each person's competencies to care for themselves, which include physical, social, cognitive and economic tasks [10], such as personal care, adaptation and compliance with the demands of the environment (Greve, 2007).

According to a systematic review published by Stuck A, et al. [11] the risk factors associated with decreased functionality are: cognitive impairment, depression, disease burden, increase and decrease in body mass index, functional limitation of the lower extremities, low frequency of social contacts, low level of physical activity, alcohol consumption, smoking and visual impairment. Similarly, socioeconomic factors and educational attainment have been found to be associated with decreased functional status [12].

In the literature reviewed, the negative relationship between changes in function, expressed in terms of a decrease in instrumental activities of daily living (ADLs) and performance in higher brain processes, has been evidenced. The deterioration of the patient's functional status can be an indicator of serious underlying diseases, in addition to being a necessary symptom to diagnose a major neurocognitive disorder [13-15]. In different studies it has been found that failures in higher cognitive functions such as executive functions and memory are associated with lower scores on scales that evaluate performance in ADLs [16-19]. However, in Colombia and specifically in Medellín no studies were found that have investigated this relationship, therefore, the objective of this study was to analyze the relationship between individual characteristics, clinical history, memory performance and executive functioning, with the functionality of daily life in adults in the city of Medellín, between 2016 and 2017.

Subjects and Methods

Study Design

This research is observational, cross-sectional, retrospective cohort.

Sampling and Data Acquisition

Clinical records and neuropsychological tests collected between January 2016 and January 2017, in the fieldwork of the Neuronorma-Co project of the Psychology and Neurosciences research group of the University of San Buenaventura-Medellín, were analyzed. There was a database of 126 adults aged between 47 and 94 years in the city of Medellín; Those records with incomplete data (>10%) were excluded in relation to the variables to be analyzed, and in those where the missing data were less than 10%, the lost value was replaced by the mean of the item.

The results of the following scales and tests, validated in Colombia, were taken into account: Learning and memory task with controlled coding by Grober and Buschke (1988), which evaluates memory, specifically coding, learning and recovery [20,21]. Executive functioning data were obtained through the Tower of London (Shallice, 1982), which specifically assesses problem-solving and planning capacity [22-25] which are fundamental for the development and achievement of plans, skills necessary for adequate performance in daily life.

Data on the functionality and presence of depression were obtained with the Modified Lawton Scale [26] and the Geriatric Depression Scale [27], respectively. In addition, the variables were taken into account: years of schooling, bilingualism, which have been associated with greater synaptic connections between the different brain areas, also, the greater the number of years studied in a person, there will be greater cognitive reserve, which is a protective factor against normal and pathological aging.

Data Processing and Analysis Techniques

Confounding biases were controlled for multiple linear regression statistical method.

To identify the clinical history associated with daily living functionality and to establish the association between memory performance, as measured by the Grober and Buschke coded controlled memory and learning task, and executive functioning with daily living functionality in the adults in the study. performed bivariate analysis to determine association or correlation between independent variables with functionality; to evaluate the qualitative variables with respect to the outcome variable, Mann Whitnney and Kruskal Wallis' U was used; for the cuantitativas variables according to their non-normal distribution, Spearman's correlation coefficient was implemented.

To determine the clinical history and variables related to memory performance and executive functioning, which contribute most to the functionality of daily life in the population of interest, a multivariate analysis was performed. The independent variables that in the bivariate ~~analysis~~ had a p<0.25 value according to Hosmer Lemeshow criteria were taken into account to estimate

the correlation in the multivariate model. To estimate the type and strength of association, among the variables, a multiple linear regression model was used.

Result

We included data from 126 adults aged 47 to 94 years between January 2016 and January 2017. The median age is around 65 years, mostly women; this population has approximately 11 years of schooling, non-bilingual, without a partner (Table 1).

Table 1: Individual characteristics of the study population in Medellín, 2016-2017 (n=126)

	p+	Me (RIQ)
Age	0,030	65 (18)
Years of schooling	0,024	11 (8)
		% (n)
Sex		
Woman		60,3 (76)
Man		39,7 (50)
Marital Status		
With partner		34,9 (44)
Without a Partner		65,1 (82)
Academic Level		
Primary		22,2 (28)
High school		31,0 (39)
Technical/Technological		20,6 (26)
Superior		23,8 (30)
No studies		2,4 (3)
Bilingualism		
No		84,1 (106)
Yes		15,9 (20)
+: Kolmogorov-Smirnov test		

Me: Median **RIC:** Interquartile range

Years of Schooling and Functionality

The variable years of schooling correlated with the functionality index (0.000), that is, the greater the schooling, the greater the functionality of the older adult. p=

Gender, Marital Status, Bilingualism and Functionality

In the analysis of the variables sex, marital status and bilingualism regarding functionality, the only significant test statistic related to the outcome variable was marital status (p=0.016) with 95% confidence, in this way, having a partner was associated with a higher functionality score.

Clinical History Associated with the Functionality

Regarding health history, the greatest correlation with the function index was ophthalmological history (, followed by risk of

depression (, neurological (and cardiovascular history (p=0,001) p=0,003)p=0,025) p=0,047).

Association Between Memory Performance and Daily Living Functionality

The components of total word identification in a first trial and total free recall correlate with the functionality index (Table 2), that is, the better the processes of storage and evocation of information, the greater the functionality.

Table 2: Association between memory performance and functionality.

Variable	Rho de Spearman	P-value
Learning and memory task with controlled coding (Grober and Buschke)		
PE Total identification [free test 1]	0,259**	0,003
PE Total free souvenir	0,322**	0,000
PE Souvenir with total key	0,174	0,051
PE Free deferred recall	0,120	0,181
PE Deferred memory with key	0,173	0,053

**The correlation is significant at the level 0.01 (two tails).
PE: Scalar score

Association Between Executive Functioning and Function in the Population

In principle, scores in times of execution () and p=0,001resolution () of the Tower of London correlated positively with the functionality index, followed by scalar scores in p=0,001Total movements and the total startup time, as measures of sequencing and resolution, respectively (Table 3).

Table 3: Association between executive functioning and daily living functionality.

Variable	Rho de Spearman	P-value
Tower of London (TOL-DX)©		
PE Total Correct movements	0,162	0,071
PE Total movements	0,221*	0,013
PE Total startup time (latency)	0,215*	0,015
PE Runtime	0,287**	0,001
PE Resolution time	0,290**	0,001

**The correlation is significant at the level 0.01 (two tails).
*The correlation is significant at the level 0.05 (two tails).
PE: Scalar score

Relationship Between Individual Characteristics, Clinical History, Memory Performance and Executive Functioning With Daily Living Functionality In The Population

An empirical model of the functionality index explained by the individual, clinical and neuropsychological variables was estimated, using the multiple linear regression methodology.

According to the model obtained, it is understood that, for each additional year of life, the functionality index decreases by 0.086.

In relation to the Tower of London test, for each point that increases the processing speed in the execution time of the problem, the functionality index is expected to increase by 0.130 points.

Finally, each year in which the schooling of an older adult increases, their functionality index is expected to increase by 0.074 points.

Discussion

The objective of this study was to investigate the relationship between individual characteristics, clinical history, memory, executive functioning and functionality of daily life in older adults, a population in which functional impairment is very common, associated with age, demographic factors (sex, age, marital status) [28], cardiovascular, endocrine/metabolic, neurological, psychiatric, ophthalmological, respiratory diseases, among others [11, 12, 29].

The bivariate analysis found an association of functional status with age, years of schooling, marital status, ophthalmological, neurological, cardiovascular history and risk of depression, in addition to performance in short-term semantic memory, planning, sequencing and problem solving. Subsequently, when performing linear regression, the results showed a relationship of functionality with age, years of schooling (cognitive reserve), the PE Execution time of the Tower of London test, and the PE in total movements. Therefore, it can be inferred that performance in executive planning, variables evaluated with the Tower of London, correlate positively with better performance in instrumental activities of daily living.

In relation to age, the expected result was obtained according to the literature, an inverse correlation between both measurements: the older the age, the lower the functionality index [2, 30-34]. Age-related changes in functional status are widely described; in a study by Meunier, Stamatakis and Tyler [35], they found that as age progresses there are changes in gray and white matter, which implies less brain connectivity, therefore, all cognitive and behavioral functions such as language comprehension, working memory and executive function, can be altered.

The functioning of daily life was also found to be correlated with years of schooling, which has been associated in previous studies with better performance in instrumental activities of daily living [9, 32, 36-39].

At the physiological level, the greater the number of neural connections available, the greater the protective factors available against the appearance of brain pathologies [38]; which has been associated with the concept of cognitive reserve, which is understood as the efficient response at the neuronal level, allowing the subject to optimize cognitive resources and respond to environmental tasks [40]. This cognitive reserve is built with the demands at the cognitive level experienced by the subject, therefore, the years of schooling, occupation, languages that the subject handles, create this reserve that is a strong predictor of performance in instrumental activities of daily living (ADL), therefore, the greater the cognitive reserve, the better the performance in this type of activities [39].

Finally, the relationship between variables of mnestic processes and executive functioning, and the functionality of daily life is a significant finding due to the importance of maintaining the independence of people in the performance of their day to day; which agrees with previous studies that conclude that deficits at the executive level interfere with the performance of ADLs, deteriorating people's quality of life [7, 41-44] As reported in the literature, deficits at the executive level are related to poor attentional control and less regulation of impulsive behaviors, as well as a low capacity for conflict resolution [45]; these executive deficits have been documented to be responsible for up to 30% of the variance of instrumental ADLs [46].

According to the model of the Higher Attentional System (SAS), proposed by Norman and Shallice, the attentional system is mediated by automatic tasks or processes and processes that require executive control. Automatic behaviors do not require supervision and develop as usual. On the other hand, the processes that require supervision are new or unusual for the subject and in which there are involved processes of problem solving, which are analyzed and supervised by the unit that the authors denominator Dimidor of Conflicts, which is responsible for analyzing and modifying the schemes already developed in the brain that allow the resolution of the task in question, In addition to creating new solutions that will allow greater efficiency in future situations and in similar conflicts. To carry out this task, the SAS is responsible for inhibiting automatic responses, canceling potentially distracting stimuli and avoiding perseverative responses based on a feedback and behavior monitoring mechanism [47,48].

Thus, it is correct to affirm that, having a deficit at the executive level, the SAS will not function adequately in complex and new situations such as those evaluated in instrumental ADLs, use of means of transport, medication management, management of economic issues, use of communication devices.

Limitations of the Study and Future Research

The main limitations of this study are related to the use of secondary data; For a similar study in the future, it would be important to be able to define inclusion/exclusion criteria outlined according to the research to be developed, taking into account that studies in the area of psychiatry and neuropsychology are affected by multiple variables.

Conclusion

The variables that were related to the functionality of daily life in adults in the city of Medellín were age, years of schooling (cognitive reserve) and the PE Execution time of the Tower of London test (executive planning) which explained 35.7% in the model.

The results corroborate the influence of these variables on the performance of functionality; it is pointed out the importance of conducting additional studies with a representative sample that allows to include a greater number of variables and investigate new correlations. Functional assessment is essential within the diagnostic and therapeutic process of adult care, given the challenge of preventing or reducing functional decline, disabilities and promoting the prevention of functional impairment.

Ethical Considerations

The study was classified as a non-risk investigation in accordance with Resolution No. 8430 of 1993 of the Ministry of Health of Colombia: By which the scientific, technical and administrative standards for health research are established, as it is a retrospective study in which no intervention or intentional modification of the biological variables is carried out, physiological, psychological or social of the individuals participating in the study. (Ministerio de salud, 1993).

All the information obtained from the histories, forms and tests of the subjects was considered confidential, respecting the considerations described in Resolution No. 1995 of 1999 Rules for the management of medical records Ministry of Health of Colombia. Access to the subjects' information was protected with scientific rigor by the researcher and the identification data of the patients were not part of the categorized database.

Protection of personal data and confidentiality of information were ensured by encrypting the records of the subjects in the database. The researcher complied with the regulations on copyright and intellectual property in Colombia.

It was approved by the CES Human Research Ethics Committee before its execution. There was no conflict of interest for the conduct of this study, nor were ethical problems estimated.

Department and Institutions Where the Work was Carried Out

Faculty of Medicine, Ces University; Faculty of Psychology, San Buenaventura University, Medellín. Research Department of Mente Plena, Medellín.

Acknowledgement

Appendix

Appendix: Annexes required by evaluators Operationalization of variables.

	VARIABLE	DEFINITION	NATURE	MEASUREMENT LEVEL	UNITS	CATEGORIZATION
	Age	Time elapsed in years from birth	Quantitative	Reason	years	
	Sex	Gender condition recorded in medical record/form	Qualitative/Dichotomous	Nominal	Not applicable	0. Male 1. Female
	Academic level	Years of formal education	Quantitative	Reason	years	
	Level of schooling	Level of schooling attained	Qualitative/Political Science	Ordinal	Not applicable	0. No studies 1. Primary 2. High school 3. Technical/Technological 4. Superior
	Marital status	Status of a person in relation to a legal situation regarding this. Unpartnered includes: Single, divorced/separated, widowed With partner: Married / free union.	Qualitative/Political Science	Nominal	Not applicable	0. With partner 1. Without a partner
	Bilingualism	Second Language Management	Qualitative	Nominal	Not applicable	0. No 1. Yes
	Smoking	Habit of consumption of tobacco derivatives Category Does not include ex-smoker	Qualitative	Nominal	Not applicable	0. No 1. Yes
	Alcohol consumption	Situation of consumption of alcoholic beverages	Qualitative	Nominal	Not applicable	0. No 1. Yes
	Cardiovascular diseases	History of cardiovascular diseases. It includes hypertension, heart failure, MI, ischemic heart disease, arrhythmia, peripheral vascular disease.	Qualitative	Nominal	Not applicable	0. Absence 1. Presence
	Endocrine diseases	History of endocrine diseases. Includes DM, thyroid disease, Hyperlipidemia.	Qualitative	Nominal	Not applicable	0. Absence 1. Presence

	Psychiatric illnesses	History of psychiatric illnesses. Includes depression, anxiety, psychosis, drug/alcohol abuse.	Qualitative	Nominal	Not applicable	0. Absence 1. Presence
	Neurological Diseases	History of neurological diseases. Includes CVD, ICT, epilepsy, ECT with loss of consciousness, headache, Parkinson's	Qualitative	Nominal	Not applicable	0. Absence 1. Presence
	Respiratory Diseases	History of respiratory diseases. Includes asthma, COPD	Qualitative	Nominal	Not applicable	0. Absence 1. Presence
	Ophthalmological diseases	History of ophthalmological diseases. Includes glaucoma and cataracts	Qualitative	Nominal	Not applicable	0. Absence 1. Presence
	Depression	Yesavage Depression Risk Categories	Qualitative	Ordinal	0-5 normal 6-10 moderate 11-15 severe	0. Normal 1. Moderate 2. Severe
	Memory: Total identification recall (free trial 1)	Performance in Grober and Buschke Test Memory	Quantitative	Interval	Typical score (EP)	
	Memory: Total free memory	Performance in Grober and Buschke Test Memory	Quantitative	Interval	Typical score (PE)	
	Memory: Memory with total key	Performance in Grober and Buschke Test Memory	Quantitative	Interval	Typical score (EP)	
	Memory: Free deferred memory	Performance in Grober and Buschke Test Memory	Quantitative	Interval	Typical score (EP)	
	Memory: Deferred memory with key	Performance in Grober and Buschke Test Memory	Quantitative	Interval	Typical score (EP)	
	Executive Performance: TOL-DX© Total Correct Movements	Scalar score in executive function Tower of London test	Quantitative	Interval	Typical score (EP)	
	Executive Performance: TOL-DX© Total Movements	Scalar score in executive function Tower of London test	Quantitative	Interval	Typical score (EP)	
	Executive Performance: TOL-DX© Total Start Time (Latency)	Scalar score in executive function Tower of London test	Quantitative	Interval	Typical score (EP)	
	Executive Performance: TOL-DX© Runtime	Scalar score in executive function Tower of London test	Quantitative	Interval	Typical score (EP)	

	Executive Performance: TOL-DX© Resolution Time	Scalar score in executive function Tower of London test	Quantitative	Interval	Typical score (EP)	
V. Result	Functionality index	Total score on Lawton scale (V. dependent)	Quantitative	Interval	Direct scoring (0-14)	

Medical History	% (n)
Alcohol Consumption	
No	88,9 (112)
Yes	11,1 (14)
Tobacco Use	
No	89,7 (113)
Yes	10,3 (13)
Cardiovascular	
No	62,7 (79)
Yes	37,3 (47)
Endocrine/Metabolic	
No	49,2 (62)
Yes	50,8 (64)
Psychiatric	
No	78,6 (99)
Yes	21,4 (27)
Neurological	
No	83,3 (105)
Yes	16,7 (21)
Ophthalmological	
No	81,7 (103)
Yes	18,3 (23)
Respiratory	
No	89,7 (113)
Yes	10,3 (13)
Geriatric Depression Scale Score (Yesavage, 1983)	
Normal (No risk)	89,7 (113)
Moderate Risk	7,1 (9)
Severe Risk	3,2 (4)

References

1. WHO (2017) 10 facts about aging and health (Internet). WHO.

2. Ward SA, Parikh S, Workman B (2011) Health perspectives: international epidemiology of ageing. Best Pract Res Clin Anaesthesiol 25(3): 305-317.

3. United Nations, USA (2021) Ageing and Disability.

4. Feigin VL, Vos T, Nichols E, Owolabi MO, Carroll WM, et al. (2020) The global burden of neurological disorders: translating evidence into policy. Lancet Neurol 19(3): 255-265.

5. Kalpouzos G, Chételat G, Baron JC, Landeau B, Mevel K, et al. (2009) Voxel-based mapping of brain gray matter volume and glucose metabolism profiles in normal aging. Neurobiol Aging 30(1): 112-124.

6. Parikh PK, Troyer AK, Maione AM, Murphy KJ (2016) The Impact of Memory Change on Daily Life in Normal Aging and Mild Cognitive Impairment. Gerontologist 56(5):877-885.

7. Reuter-Lorenz PA, Festini SB, Jantz TK (2016) Executive Functions and Neurocognitive Aging. Chapter 13, In: Schaie KW, Willis SL (Eds.), Handbook of the Psychology of Aging [Eighth Edition], pp. 245-262.

8. Mattson MP, Arumugam TV (2018) Hallmarks of Brain Aging: Adaptive and Pathological Modification by Metabolic States. Cell Metab 27(6): 1176-1199.

9. Gill TM, Williams CS, Richardson ED, Tinetti ME (1996) Impairments in physical performance and cognitive status as predisposing factors for functional dependence among nondisabled older persons. J Gerontol A Biol Sci Med Sci 51(6): M283-M288.

10. Lobo A, Paula Santos M, Carvalho J (2007) Institutionalized anciano: calidad de vida y funcionalidad. Rev Esp Geriatr Gerontol 42(Suppl 1): 22-26.

11. Stuck AE, Walthert JM, Nikolaus T, Büla CJ, Hohmann C, et al. (1999) Risk factors for functional status decline in community-living elderly people: a systematic literature review. Soc Sci Med 48(4): 445-469.

12. Beydoun MA, Popkin BM (2005) The impact of socio-economic factors on functional status decline among community-dwelling older adults in China. Soc Sci Med 60(9): 2045-2057.

13. López MR (2017) Cognitive impairment/dementia: assessment and follow-up. Functional aspects. Rev Esp Geriatr Gerontol 52: 28-33.

14. Boyle PA, Paul RH, Moser DJ, Cohen RA (2004) Executive impairments predict functional declines in vascular dementia. Clin Neuropsychol 18(1): 75-82.

15. D'Onofrio G, Sancarlo D, Panza F, Copetti M, Cascavilla L, et al. (2012) Neuropsychiatric symptoms and functional status in Alzheimer's disease and vascular dementia patients. Curr Alzheimer Res 9(6):759-771.

16. Schillerstrom JE, Birkenfeld EM, Yu AS, Le MP, Goldstein DJ, et al. (2013) Neuropsychological correlates of performance based functional status in elder adult protective services referrals for capacity assessments. J Elder Abuse Negl 25(4): 294-304.

17. Perneczky R, Pohl C, Sorg C, Hartmann J, Tosic N, et al. (2006) Impairment of activities of daily living requiring memory or complex reasoning as part of the MCI syndrome. Int J Geriatr Psychiatry 21(2): 158-162.

18. Farias ST, Mungas D, Reed BR, Harvey D, Cahn-Weiner D, et al. (2006) MCI is associated with deficits in everyday functioning. Alzheimer Dis Assoc Disord 20(4): 217-223.

19. Ballesteros S, Kraft E, Santana S, Tziraki C (2015) Maintaining older brain functionality: A targeted review. Neurosci Biobehav 55: 453-477.

20. Peña-Casanova J (2020) Manual of application protocol of screening tests and neuropsychological evaluation. Neuronorm, Colombia.

21. Buschke H (1984) Cued recall in Amnesia. J Clin Neuropsychol 6(4): 433-40.

22. Orozco CG, Ostrosky SF (2012) Frontal Lobes and Executive Functions in Transsexuals. Psychological Research Records 2(1): 592-604.

23. Peña-Casanova J, Sánchez-Benavides G, de Sola S, Manero-Borrás RM, Casals-Coll M, et al. (2012) Neuropsychology of Alzheimer's disease. Arch Med Res 43(8): 686-693.

24. Peña-Casanova J, Quiñones-Ubeda S, Gramunt-Fombuena N, Quintana M, Aguilar M, et al. (2009) NEURONORMA Study Team. Spanish Multicenter Normative Studies (NEURONORMA Project): norms for the Stroop color-word interference test and the Tower of London-Drexel. Arch Clin Neuropsychol 24(4): 413-429.

25. Dansilio S, Horta K, Beisso A, Agudelo N, Larrea F, et al. (2010) The Tower of London during school-age development: Performance standards in a Uruguayan population. Revista Argentina de Neuropsicología 15: 14-33.

26. Lawton MP, Brody EM (1969) Assessment of older people: self-maintaining and instrumental activities of daily living. Gerontologist 9(3): 179-86.

27. Yesavage JA, Brink TL, Rose TL, Lum O, Huang V, et al. (1982) Development and validation of a geriatric depression screening scale: a preliminary report. J Psychiatr Res 17(1): 37-49.

28. Segovia DL, Martha G, Torres H, Erika A (2011) Functionality of the elderly and nursing care. Gerokomos 22(4): 162-166.

29. Sitjas ME, San JL, Armadans GA, Mundet TL, Vilardell TM, et al. (2003) Predictors factors about functional decline in community-dwelling older persons. Aten Primaria 32(5): 282–287.

30. Schuff N, Amend DL, Knowlton R, Norman D, Fein G, et al. (1999) Age-related metabolite changes and volume loss in the hippocampus by magnetic resonance spectroscopy and imaging. Neurobiol Aging 20(3): 279-285.

31. Carlos MJ, Tomás JM, Navarro E (2011) Activities of daily living and well-being and their relationship to age and gender in old age. Annals of Psychology 27(1): 164-169.

32. Lachman ME, Agrigoroaei S (2010) Promoting functional health in midlife and old age: long-term protective effects of control beliefs, social support, and physical exercise. PLoS One 5(10): e13297.

33. Zavala-González, Marco Antonio, Domínguez-Sosa, Guadalupe (2011) Functionality for daily living in older adults. Revista Médica del Instituto Mexicano del Seguro Social 49(6): 585-590.

34. Giraldo MCI (2008) Functional capacity and health: guidelines for caring for the elderly1. Advances in Nursing 26(1): 43-58.

35. Meunier D, Stamatakis EA, Tyler LK (2014) Age-related functional reorganization, structural changes, and preserved cognition. Neurobiol Aging 35(1): 42-54.

36. Tucker AM, Stern Y (2011) Cognitive reserve in aging. Curr Alzheimer Res 8(4): 354-60.

37. Cahn-Weiner DA, Boyle PA, Malloy PF (2002) Tests of executive function predict instrumental activities of daily living in community-dwelling older individuals. Appl Neuropsychol 9(3): 187-191.

38. Barnett JH, Salmond CH, Jones PB, Sahakian BJ (2006) Cognitive reserve in neuropsychiatry. Psychol Med 36(8): 1053-1064.

39. Suchy Y, Kraybill ML, Franchow E (2011) Instrumental activities of daily living among community-dwelling older adults: discrepancies between self-report and performance are mediated by cognitive reserve. J Clin Exp Neuropsychol 33(1): 92-100.

40. Cancino M, Rehbein-Felmer L, Ortiz MS (2018) Cognitive reserve, depression and social support. Analysis of 206 older adults. Revista médica de Chile 146(3): 315-322.

41. Diamond A (2013) Executive functions. Annu Rev Psychol 64: 135-168.

42. Hanna-Pladdy B (2007) Dysexecutive syndromes in neurologic disease. J Neurol Phys Ther 31(3): 119-127.

43. Wecker NS, Kramer JH, Wisniewski A, Delis DC, Kaplan E, et al. (2020) Age effects on executive ability. Neuropsychology14(3): 409-414.

44. Flores-Lázaro JC, Castillo-Preciado RE, Jiménez-Miramonte NA (2014) Development of executive functions, from childhood to youth. Annals of Psychology 30(2): 463-473.

45. Pereira FS, Yassuda MS, Oliveira AM, Forlenza OV (2008) Executive dysfunction correlates with impaired functional status in older adults with varying degrees of cognitive impairment. Int Psychogeriatr 20(6): 1104-1115.

46. Paula JJ de, Malloy-Diniz LF (2013) Executive functions as predictors of functional performance in mild Alzheimer's dementia and mild cognitive impairment elderly. Estud psicol 18(1): 117-124.

47. Tirapu-Ustárroz J, García-Molina A, Luna-Lario P, Roig-Rovira T, Pelegrín-Valero C, et al. (2008) Models of functions and executive control (II). Rev Neurol 46(12): 742-750.

48. JMD strike (2007) Treatise on Rehabilitation Medicine. São Paulo: Roca, pp. 694-703.

Your next submission with Juniper Publishers will reach you the below assets

- Quality Editorial service
- Swift Peer Review
- Reprints availability
- E-prints Service
- Manuscript Podcast for convenient understanding
- Global attainment for your research
- Manuscript accessibility in different formats
  (Pdf, E-pub, Full Text, Audio)
- Unceasing customer service

Track the below URL for one-step submission
https://juniperpublishers.com/online-submission.php