Original Article

Elderly Hypertensives Show Decreased Cognitive Performance Compared with Elderly Normotensives

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Abstract

Background: **Essential hypertension has been associated with decreased cognitive performance; however, the literature is conflicting.**

Objective: **This study aims at comparing cognitive performance between elderly normotensives ("N"; n = 17; age 68 ± 1; blood pressure = 133 ± 3/74 ±2 mmHg) and hypertensives ("H"; n = 28; age 69 ± 1, blood pressure = 148 ± 4/80 ± 1mmHg) with at least 5 years of education.**

Methods: **The comprehensive neuropsychological assessment was comprised of the Cambridge Cognition-Revised (CAMCOG-R), the Trail Making Test A and B (TMT A and B) and the Rey Auditory Verbal Learning Test (RAVLT).**

Results: **Elderly hypertensives presented lower CAMCOG-R global scores (N = 87.6 ± 1.8; H = 78.6 ± 1.4; p = 0.002). The hypertensive's performance was slower in the TMT A and B (TMT A: N = 39 ± 3s; H = 57 ± 3s; p = 0.001; TMT B: N = 93 ± 7s; H = 124 ± 7s; p = 0.006), which was also reflected in smaller percentiles achieved by hypertensives in these tests. Hypertensive subjects exhibited a significantly lower RAVLT summation score (N = 51.8 ± 1.7; H = 40.7 ± 1.5; p < 0.0001). Even when adjusted for age, sex, education and depression symptoms, hypertension was an independent predictor of cognitive performance as measured by CAMCOG-R global score, TMT A and RAVLT summation score.**

Conclusion: **Cognitive performance is lower in elderly hypertensives as compared with elderly normotensives (Arq Bras Cardiol. 2013; 100(5):444-451).**

Keywords: **Hypertension; Aged; Cognition.**

Introduction

According to the Brazilian Institute of Geography and Statistics (IBGE), there are 18 million people over 60 years of age living in the country, representing 12% of the population[1].

Population aging is associated with an increased prevalence of chronic diseases, including high blood pressure (HBP)[2]. HBP is considered to be an important risk factor for multiple diseases, such as coronary insufficiency, stroke and renal insufficiency, which are also associated with changes in cognitive performance[3-5]. According to the Ministry of Health[6], the proportion of Brazilians diagnosed with HBP has grown from 21.5% in 2006 to 24.4% in 2009. This study was performed with 54 thousand adults and showed that the predominance of the disease in the period 2006 through 2009 increased in all age ranges. Currently, 63.2% of people aged 65 years of age or older have HBP, compared with 57.8% in 2006[6].

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Elderly hypertensives, compared with elderly normotensives, are at increased risk of cognitive decline, including slow response and declining memory and executive functioning[7-9]. In addition, untreated elderly hypertensives present a higher risk of cognitive loss than treated elderly hypertensives[9-14]. However, some studies reveal a negative association between HBP and cognitive deficit[15-17]. Therefore, the relationship between HBP and changes in cognitive performance in the elderly is not fully understood. Some of the conflicting results in the literature can be attributed to the use of insufficiently sensitive neuropsychological assessment instruments such as the Mini Mental State Examination (MMSE). The goal of the present study is to evaluate and compare cognitive performance in elderly hypertensives and normotensives through the employment of different neuropsychological assessment instruments, which allows for a detailed diagnosis of the various cognitive domains potentially altered in these individuals.

Methods

This was a randomized, observational, cross-sectional and comparative study. Normotensive subjects (n = 17) and hypertensive subjects (n = 28) aged ≥ 60 years and < 80 years with at least 5 years of education were included. In order to be considered hypertensive, subjects were required to have a systolic pressure ≥ 140 mmHg and/

or diastolic pressure ≥ 90 mmHg, or were taking stable antihypertensive medication for at least 3 months. These people were recruited from outpatient geriatric and general medical clinics, and from the university outreach program of the University Open to the Third Age (UNATI, as per its acronyms in Portuguese) of the Rio de Janeiro State University (UERJ).

We excluded elderly patients with left ventricular systolic dysfunction, atrial fibrillation or other clinically relevant arrhythmias, diabetes mellitus type 1 or 2, renal insufficiency, history of transient ischemic attack or stroke, Parkinson's disease, use of psychotropic medications, dementia, abnormal results of MMSE according to level of education (24/25, ≥ 1 year education), individuals with uncorrected sensory deficits, those confined to a wheelchair or those with motor deficits that could compromise performance in neuropsychological testing. We also excluded older adults with systolic blood pressure ≥ 180 mmHg and/or diastolic blood pressure ≥ 110 mmHg and those individuals using four or more antihypertensive medications.

Two groups were studied: elderly hypertensives (n = 28) and elderly normotensives (n = 17). The participants underwent a thorough physical examination performed by a cardiologist. Blood pressure was measured with the patient in the sitting position, after a 10-minute rest, with an automatic sphygmomanometer (Omron HEM-711, Omron Healthcare, USA)[18]. Blood pressure values used in the study correspond to the average of three measurements at least 5 minutes apart.

The study was approved by the Research Ethics Committee of the Pedro Ernesto University Hospital of UERJ. According to Resolution No. 196/1996 of the National Health Council, all volunteers agreed to participate and signed a consent form.

Neuropsychological assessment

Neuropsychological assessment consisted of the Cambridge Cognition Examination-Revised (CAMCOG-R), which is section B of the cognitive assessment of the Cambridge Examination for Mental Disorders of the Elderly-revised (CAMDEX-R)[19] adapted and validated for Portuguese[20], by the Trail Making Test A and B (TMT A and B)[21], and by the Rey Auditory Verbal Learning Test (RAVLT)[22]. To screen for depression, the Brazilian version of Beck's Depression Inventory was used[23].

The neuropsychological evaluations were conducted over two days, always in the morning by a single researcher trained and supervised by a neuropsychologist. The researcher who applied the neuropsychological tests was not "blind" regarding the hypertension diagnosis. However, the measurements taken were mostly objective, and it was not up to the researcher to interpret the results. Each meeting lasted approximately one hour and a half. On the first day we administered CAMCOG-R and Beck's Depression Inventory, and on the second day the RAVLT and TMT A and B. The results of the neuropsychological evaluations were organized and analyzed by the same investigator who conducted the tests.

Sample size calculation and statistical analysis

To calculate the sample size, we considered that the averages and standard deviations from the overall score on the CAMCOG-R of hypertensives and normotensives would be comparable to the averages and standard deviations observed in groups with minimal cognitive impairment and the control groups, respectively, in the study performed by Nunes et al[24]. Therefore, the average and standard deviation of the overall score on the CAMCOG-R in the elderly normotensives group was estimated at 99±3; in the elderly hypertensives it was estimated at 91±7. Considering a p-value of 0.05 and a study power of 0.95, the minimum sample size per group was estimated at 14. The sample size was calculated by means of the GPower 3.1.0 program of Kiel University, Germany.

The results were presented in the form of average ± standard error or median and respective minimum and maximum values and interquartile intervals. We used Mann Whitney *U* test for discrete variables with distribution presumably not normal[25]. The continuous or discrete variables with normal distribution were evaluated by unpaired Student t test with similar variance for both groups. Multivariate linear regression analysis was used to verify the effect of the presence of hypertension, adjusted for age, sex, education and depression symptoms, over several scores of cognitive performance. The p-value < 0.05 was considered statistically significant. For statistical calculations, we used Excel (Microsoft, 2007) and SPSS v.20 (IBM, 2011).

Results

The sociodemographic characteristics of the study groups are shown in Table 1. Age, sex, marital status, smoking habits, physical activity, body mass index, and Beck's Depression Inventory scores are similar in both groups. However, the education levels of elderly hypertensives are significantly lower. As expected, the values of systolic and diastolic pressures are higher in hypertensive individuals.

The elderly hypertensives showed a lower cognitive performance compared with normotensives by global score of CAMCOG-R (Table 2). When evaluated by the isolated cognitive domain of CAMCOG-R, the comprehension and expression of language, remote memory, attention, praxes, executive functioning and perception were significantly lower in the elderly hypertensives (Table 2). In Table 3, we demonstrate the results of TMT A and B and RALVT. The elderly hypertensives had a significantly slower performance than the normotensives in TMT A and B. The cognitive performance of the elderly hypertensives in RALVT was also significantly lower than that of the normotensives, as evidenced by the lower sum of A1-A5.

Regardless of controlling for age, sex, education and Beck's Depression Inventory score, the presence of high blood pressure is an independent predictor of lower cognitive performance measured by the overall score of CAMCOG-R, by the time and percentile of TMT-A, and sum of A1-A5 of the RAVLT in the elderly (Tables 4 and 6). When controlling for age, sex, education and Beck's Depression Inventory score, only the scores of the domains of praxes and learning on the CAMCOG-R are significantly reduced by the presence of high blood pressure in the elderly (Table 5).

Table 1 – Sociodemographic characteristics of the participants

	Hypertensive	Normotensive	p-value
Sample size	28	17	-
Female (%)	15 (53.6)	9 (52.9)	-
Male (%)	13 (46.4)	8 (47.1)	-
Schooling in years	8 ± 1	11 ±1	0.02
Age	69 ±1	68 ± 1	0.7
Single (%)	3 (10.7)	2 (11.8)	-
Married (%)	20 (71.4)	13 (76.5)	-
Widowed (%)	5 (17.8)	2 (11.8)	-
Systolic BP., mmHg	148 ± 4	133 ±3	0.007
Diastolic BP., mmHg	80 ± 1	74 ± 2	0.03
Beck's depression scale score	5 (2-10/2)*	4 (0-7/3)*	0.3#
Smokers (%)	1 (3.6)	1 (5.8)	-
Non sedentary (%)	3 (10.7)	4 (23.5)	-
Body mass index	27.5 ± 5	25.2 ± 4	0.7

**Results expressed in median (minimum value – maximum value / interquartile value); other on average ± EP; #P-value associated to U test of Mann-Whitney and the other are associated to Student t-test; BP: Blood pressure.*

Table 2 – Global score and scores by cognitive domain evaluated by CAMCOG-R

	Hypertensives	Normotensives	p-value
Global scores	78.6 ± 1.4	87.6 ± 1.8	0. 0002*
Temporal orientation	5 (4-5/0)	5 (5-5/0)	0.6
Spatial orientation	5 (4-5/0)	5 (5-5/0)	0.2
Language understanding	9 (7-9/1)	9 (9-9/0)	0.01
Language expression	17.5 (15-20/2)	19 (17-22/3)	0.02
Remote memory	3 (1-6/2.3)	4 (1-6/3)	0.02
Recent memory	4 (2-4/1)	4 (2-4/0)	0.1
Verbal fluency	13.5 (11-21/4.5)	15 (9-26/8)	0.4
Attention	3 (2-7/1)	6 (2-7/4)	0.01
Praxes	15 (10-17/2)	16 (15-18/1)	< 0.001
Calculation	2 (1-2/0)	2 (1-2/0)	0.9
Executive function	9.5 (3-20/4.3)	15 (4-21/6)	0.006
Perception	5 (3-8/1)	6 (4-8/1)	0.01

**Results of global score of CAMCOG-R expressed on average ± EP for CAMCOG-R; other scores expressed on median (minimum value – maximum value / interquartile interval); #P-value associated to Student t-test; other P-values associated to U test f Mann-Whitney.*

Discussion

The results of neuropsychological assessments used in this study suggest that elderly patients with hypertension have reduced performance in several cognitive domains when compared with elderly normotensives. Specifically, elderly hypertensives had lower overall scores on the CAMCOG-R, whether or not adjustment was made for age, sex, education and Beck's depression score. When adjusting for these factors, performance in the domains of praxes and learning of the CAMCOG-R is reduced in elderly hypertensives. The performance of elderly hypertensives was slower in the TMT A and B, which is also demonstrated by significantly lower percentiles obtained by these individuals. Likewise, the sum of RAVLT was significantly lower in elderly hypertensives. However, when adjusted for age, sex, education and Beck's depression score, the presence of hypertension in the elderly is no longer an independent predictor of speed and percentile on the TMT-B.

Table 3 – Cognitive performance in TMT A and B and in RAVLT

Test		Hypertensives	Normotensives	p-value
TMT A	Time (s)	57 ±3*	39 ± 3*	0.001#
	Percentile	24.2 ± 3.0*	45.6 ± 5.8*	0.001#
TMT B	Time (s)	124 ± 7*	93 ± 7*	0.006#
	Percentile	31.9 ± 3.5*	47.2 ± 6.2*	0.02#
RAVLT	A1	5 (1-8/1.3)	6 (5-9/2)	0.03
	A2	7 (3-11/2)	9 (5-12/3)	0.11
	A3	8 (4-12/2)	11 (7-14/2)	0.04
	A4	11 (6-13/2.3)	12 (10-15/2)	0.06
	A5	11.5 (5-13/2)	13 (10-15/2)	0.01
	∑ A1 A5	40.7 ± 1.5*	51.8 ± 1.7*	< 0.0001#
	REC	18.7 ± 0.7*	20.5 ± 0.8*	0.08#

**Results expressed on average ± EP and the other on median (minimum value – maximum value/interquartile interval); #P-value associated to Student t test and the others are associated to Mann-Whitney's U test; s: seconds; REC: recognition.*

Table 4 – Results of the linear regressions in which the dependent variable is the global score of CAMCOG-R and the independent variable is the presence of systemic arterial hypertension, controlled or not for age, sex, education and Beck's depression score

Model	Independent Variable	B (SD)	Beta	p-value of B	p-value of the model	R^2
Not Controlled	HBP	-9.00 (2.27)	-0.52	< 0.001	< 0.001	0.25
Controlled	HBP	-5.69(2.18)	-0.33	0.01	< 0.001	0.44
	Sex	2.07(1.93)	-0.09	0.5	-	-
	Age	2.07(1.93)	0.12	0.9	-	-
	Education	1.06(0.26)	0.51	< 0.001	-	-
	Beck's Score	-0.16(0.52)	-0.04	0.8	-	-

B: coefficient not standardized in the presence of systemic arterial hypertension; Beta-coefficient standardized in the presence of systemic arterial hypertension; SD: standard deviation; the constants were omitted for convenience.

Overall, our results are in agreement with the literature, which revealed an association between hypertension and decreased cognitive performance[5,26]. For instance, a cross-sectional study performed by Harrington et al[8] examined the cognitive performance of 107 untreated hypertensives and 116 normotensives older than 70 years of age, using a battery of computerized neuropsychological tests. Thus, we evaluated the following areas: attention, processing speed, concentration, working memory, spatial memory, accuracy and ability to store and retrieve new information. Notably, older hypertensive patients had significantly worse performances in all areas evaluated. Furthermore, a longitudinal study by Elias et al[26] evaluated the cognitive performance of more than 500 participants from the Maine-Syracuse Longitudinal Study of Hypertension, assessed by WAIS (Wechsler Adult Intelligence Scale). The subjects were divided by age into groups from 18 to 46 years and from 47 to 83 years and assessed over 20 years. Higher measurements of systolic and diastolic blood pressure were significantly associated with cognitive decline in the areas of visualization and fluid abilities in both groups. We observe that several studies with a longitudinal outline indicate an association between HBP and declining cognitive performance[27].

However, associations between HBP and changes in cognitive performance were not always observed[15,16]. For instance, no significant association was found between HBP and cognitive performance in the elderly 64 years of age or older evaluated by MMSE[28-30]. Such results could be attributed to a reduced sensitivity of the MMSE (a tracking test used to detect discreet cognition changes) and the difficulty in applying the MMSE for the assessment of isolated cognitive areas[13]. However, using the same MMSE, Guo et al[31] studied 1736 elderly individuals between 75 and 101 years of age for three years and observed that blood pressure is associated with a reduced global score on the MMSE. The large sample size and longitudinal design of this study reinforce the robustness of the results observed. Despite being in accordance with our results, this study recruited individuals significantly older and presumably more susceptible to cognitive decline, and therefore it was not possible to rule out an association between very advanced age and hypertension.

Table 5 – Results of linear regressions whose dependent variables are the cognitive domains of CAMCOG-R, being the independent variable at the present of systemic arterial hypertension, controlled or not for age, sex, education and Beck's depression score

Global score or domain	Model	B (SD)	Beta	p-value of B	p-value of the model	R^2
Temporal orientation	Non Controlled	-0.05 (0.09)	-0.08	0.6	0.6	< 0.01
	Controlled	0 (0.1)	0	0.9	0.5	< 0.01
Spatial orientation	Non Controlled	-0.11(0.07)	-0.21	0.2	0.2	0.02
	Controlled	-0.05(0.08)	-0.09	0.5	0.1	0.10
Language understanding	Non Controlled	-0.36(0.14)	-0.37	0.01	0.01	0.12
	Controlled	-0.39(0.15)	-0.41	0.02	0.1	0.08
Language expression	Non Controlled	-1.3(0.5)	-0.39	0.007	0.07	0.14
	Controlled	-0.8(0.5)	-0.25	0.1	0.01	0.21
Verbal fluency	Non Controlled	-1.5(1.2)	-0.18	0.2	0.2	0.01
	Controlled	-0.4(1.3)	-0.06	0.7	0.2	0.06
Remote memory	Non Controlled	-1.2(0.5)	-0.36	0.01	0.01	0.11
	Controlled	-0.5(0.4)	-0.14	0.2	< 0.001	0.49
Recent memory	Non Controlled	-0.2(0.2)	-0.18	0.2	0.2	< 0.01
	Controlled	-0.1(0.2)	-0.10	0.5	0.6	< 0.01
Learning	Non Controlled	-1.2(0.4)	-0.40	0.007	0.007	0.14
	Controlled	-1.2(0.5)	-0.38	0.01	0.02	0.20
Attention	Non Controlled	-1.5(0.5)	-0.40	0.006	0.006	0.14
	Controlled	-1.1(0.6)	-0.30	0.06	0.03	0.17
Praxes	Non Controlled	-1.6(0.4)	-0.5	< 0.001	< 0.001	0.24
	Controlled	-1.2(0.5)	-0.4	0.02	0.004	0.26
Calculation	Non Controlled	0(0.1)	-0.02	0.9	0.9	< 0.01
	Controlled	0(0.1)	0.05	0.8	0.3	0.02
Executive function	Non Controlled	-3.9(1.3)	-0.41	0.005	0.005	0.15
	Controlled	-2.1(1.3)	-0.23	0.1	0.001	0.32
Perception	Non Controlled	-1.0(0.4)	-0.37	0.01	0.01	0.12
	Controlled	-0.6(0.4)	-0.23	0.1	0.008	0.23
Executive function (28)	Non Controlled	-3.8(1.5)	-0.37	0.01	0.01	0.12
	Controlled	-2.2(1.4)	-0.22	0.1	0.008	0.31

B: coefficient not standardized in the presence of systemic arterial hypertension; Beta: coefficient standardized in the presence of systemic arterial hypertension; SD: standard deviation; the constants and the coefficients of age, sex, education and Beck's depression score were omitted for convenience.

In turn, Izquierdo-Porrera and Waldstein[17] found no significant correlation between blood pressure and cognitive performance in 43 subjects aged 43 to 82 years, assessed through a more complete set of neuropsychological tests. Specifically, the neuropsychological evaluation consisted of the clock drawing test, the Executive Interview 25 (EXIT 25) for assessment of executive function, testing of digits in the forward and reverse order and a test to assess learning. The negative results observed could be attributed to the inclusion of individuals who were relatively young when compared with the individuals in the study presented here.

A unique feature of this project was the use of the CAMCOG-R for cognitive assessment of the elderly hypertensive individuals. To our knowledge, ours is the only study that has used CAMCOG-R for this purpose. Therefore, reduction of the global score on the CAMCOG-R corroborates the results of the literature that showed a reduction in cognitive performance in elderly hypertensive subjects evaluated with other instruments. This observation is consistent with the concept that hypertension is in fact associated with reduced cognitive performance. Also shown in this study, the slower performance in TMT-A suggests a reduction in the speed of information processing. The reduced performance in RAVLT, in turn, suggests a reduction in the ability to learn new information. Other authors also find deficits in these specific cognitive domains in elderly hypertensive subjcts[32,33].

Table 6 – Results of linear regressions whose dependent variables are the performances in TMT-A and B, and in RAVLT, being the independent variable at the present of systemic arterial hypertension, controlled or not for age, sex, education and Beck's depression score

	Model	B (SD)	Beta	p-value of B	p-value of the model	R^2
TMT-A (time)	Non Controlled	17.83(5.16)	0.46	0.01	0.01	0.20
	Controlled	12.45(5.36)	0.33	0.03	0.01	0.31
TMT-A (percentile)	Non Controlled	-25.41(5.32)	-0.59	< 0.001	< 0.001	0.33
	Controlled	-21.81(6.07)	-0.51	0.001	0.02	0.30
TMT-B (time)	Non Controlled	31.20(10.88))	0.40	0.006	0.006	0.14
	Controlled	17.85(10.74)	0.23	0.1	0.001	0.33
TMT-B (percentile)	Non Controlled	-16.83(6.33)	-0.38	0.01	0.01	0.12
	Controlled	-10.64(6.29)	-0.24	0.1	0.002	0.30
RAVLT ∑A1-5	Non Controlled	-11.05(2.27)	-0.59	< 0.001	< 0.001	0.34
	Controlled	-8.74(1.99)	-0.47	< 0.001	< 0.001	0.59

B: coefficient not standardized in the presence of systemic arterial hypertension; Beta: coefficient standardized in the presence of systemic arterial hypertension; SD: standard deviation; the constants and the coefficients of age, sex, education and Beck's depression score were omitted for convenience.

Some important limitations of the study should be discussed. A potential criticism would be its small sample size. As explained in detail in the methods section, however, it should be noted that the number of participants recruited per group exceeded the minimum number, which gives the study a power of 95% to find a difference of 8 points on average in the global score of the CAMCOG-R, with a p-value of < 0.05. Another limitation has to do with the analysis of multiple secondary outcomes, for which the power of the study was not defined *a priori*. Therefore, the results relative to the performance specific to cognitive domains should be considered with caution. It is emphasized, however, that the study demonstrates a significantly lower cognitive performance in hypertensive participants reflected in its main outcome, i.e. the global score of the CAMCOG-R.

It is known that the cognitive performance measured by CAMCOG-R is significantly influenced by level of education[34]. To minimize this bias, participants with at least 5 years of formal study were evaluated. Despite this, it was found that the group of normotensives was significantly better educated. However, adjusting for age, sex, education and Beck's score, we show that the presence of hypertension is an independent predictor of cognitive performance measured by the global score on the CAMCOG-R, the time and percentile on the TMT A and the sum of A1-A5 of the RAVLT. Nevertheless, it is noteworthy that, in our case, the estimated effect of schooling is more accurate than the effect of hypertension when compared with the prediction of overall score on the CAMCOG-R. Specifically, although the unadjusted coefficient ("B") of the hypertension factor has an absolute value greater than the coefficient associated with education, the confidence interval of 95% (CI 95%) related to schooling is much narrower than that related to hypertension ("B" hypertension = - 5.69 with CI 95% of -10.1 up to -1.27 and p-value = 0.01; "B" schooling = 1.06, CI 95% of 0.52 up to 1.59 and p-value < 0.001).

Depression is also associated with reduced cognitive performance[35]. In this study, the Beck's Depression Inventory score was similar in elderly hypertensives and normotensives. Thus, the impact of symptoms associated with depression was homogeneously distributed between the two groups, attenuating the possibility of bias. Moreover, in none of the multiple linear regression models did Beck's depression scale prove to be an independent predictor of cognitive performance (results not shown).

The use of antihypertensive medications by elderly hypertensive participants could confound the results. However, there would be a tendency to underestimate the impact of hypertension on the cognitive performance[10-14]. In fact, a few studies suggest that the pharmacological treatment of hypertension prevents the development and progression of cognitive decline[10,14]. It is further emphasized that none of the elderly hypertensives were being treated with beta blockers that could *per se* reduce cognitive performance. In addition, the use of psychotropic medications was prohibited by the study protocol. Therefore, it is presumed that the impact of the use of medication is not associated with the reduction of cognitive performance observed in subjects with hypertension. Furthermore, the results cannot be extrapolated for the elderly with severe hypertension, since those with systolic blood pressure ≥ 180 mmHg and/or diastolic blood pressure ≥ 110 mmHg, or those using four or more antihypertensive medications, were excluded from the study. Finally, we emphasize that the study was cross-sectional. Consequently, one cannot establish a causal relationship between hypertension and cognitive decline.

Conclusions

The present study confirms and expands the concept that hypertension is associated with reduced cognitive performance in elderly individuals. By means of various neuropsychological assessment tools, it was demonstrated that the decline in performance occurs in different domains

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of cognition, suggesting that the neuropsychological disorder in elderly hypertensives is not located in isolated areas of the brain, contrary to what was previously observed in other studies in the literature[36]. Although there is a measurable reduction in the cognitive performance of elderly hypertensives, the study does not present evidence that this performance reduction is clinically significant, because the participation of individuals with dementia or with an established diagnosis of stroke was not permitted. However, the results of this and other studies suggest the psychobiological plausibility of this hypothesis.

Author contributions

Conception and design of the research, Writing of the manuscript and Critical revision of the manuscript for intellectual content: Matoso JMD, Santos WB, Moreira IFH, Lourenço RA, Correia MLG; Acquisition of data: Matoso JMD, Santos WB; Analysis and interpretation of the data: Matoso JMD, Santos WB, Moreira IFH, Correia MLG; Statistical analysis: Correia MLG.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Study Association

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References

1. Instituto Brasileiro de Geografia e Estatística (IBGE). Censo demográfico 2010. [Acesso em 2011 jan 10]. Disponível em: http//www.ibge.gov.br.
2. Veras R. Em busca de uma assistência adequada à saúde do idoso: revisão da literatura e aplicação de um instrumento de detecção precoce e de previsibilidade de agravos. Cad Saúde Pública. 2003;19(3):705-15.
3. Björklund K, Lind L, Zethelius B, Andrén B, Lithell H. Isolated ambulatory hypertension predicts cardiovascular morbidity in elderly men. Circulation. 2003;107(9):1297-302.
4. Franco V, Oparil S, Carretero, OA. Hypertensive therapy: part II. Circulation. 2004;109(25):3081-8.
5. Brady CB, Spiro A 3rd, Gaziano JM. Effects of age and hypertension status on cognition: the Veterans Affairs Normative Aging Study. Neuropsychology. 2005;19(6):770-7.
6. Ministério da Saúde 2010. Portal da Saúde. Hipertensão. [Acesso em 2011 fev 8]. Disponível em: http//www.portal.saude.gov.br.
7. Elias MF, Wolf PA, D'Agostino RB, Cobb J, White LR. Untreated blood pressure level is inversely related to cognitive functioning: the Framingham Study. Am J Epidemiol. 1993;138(6):353-64.
8. Harrington F, Saxby BK, McKeith IG, Wesnes K, Ford GA. Cognitive performance in hypertensive and normotensive older subjects. Hypertension. 2000;36(6):1079-82.
9. Papademetriou V. Blood pressure regulation and cognitive function: A review of the literature. Geriatrics. 2005;60(1):20-4.
10. Murray MD, Lane KA, Gao S, Evans RM, Unverzagt FW, Hall KS, et al. Preservation of cognitive function with antyhipertensive medications: a longitudinal analysis of community-based sample of African Americans. Arch Intern Med. 2002;162(18):2090-6.
11. Forette F, Seux ML, Staessen JA, Thijs L, Babarskiene MR, Babeanu S, et al. Systolic Hypertension in Europe Investigators. The prevention of dementia with antihypertensive treatment: new evidence from Systolic Hypertension in Europe (Syst-Eur) study. Arch Intern Med. 2002;162(18):2046-52.
12. Tzourio C, Anderson C, Chapman N, Woodward M, Neal B, MacMahon S, et al. Effects of blood pressure lowering with perindopril and indapamide therapy on dementia and cognitive decline in patients with cerebro vascular disease. Arch Intern Med. 2003;163(9):1069-75.
13. Birns J, Morris R, Donaldson N, Kalra L. The effects of blood pressure reduction on cognitive function: a review of effects based on pooled data from clinical trials. J Hypertens. 2006;24(10):1907-14.
14. Novak V, Hajjar I. The relationship between blood pressure and cognitive function. Nat Rev Cardiol. 2010;7(12):686-98.
15. Farmer ME, White LR, Abbott RD, Kittner SJ, Kaplan E, Wolz MM, et al. Blood pressure and cognitive performance: the Framingham Study. Am J Epidemiol. 1987;126(6):1103-14.
16. Scherr PA, Hebert LE, Smith IA, Evans DA. Relation of blood pressure to cognitive functions in the elderly. Am J Epidemiol. 1991;134(11):1303-15.
17. Izquierdo-Porrera AM, Waldstein SR. Cardiovascular risk factors and cognitive function in African Americans. J Gerontol B Psychol Sci Soc Sci. 2002;57(4):P377-80.
18. Iglesias Bonilla P, Mayoral Sanchez E, Lapetra Peralta J, Iborra Oquendo M, Villalba Alcalá F, Cayuela Domínguez A. [Validation of two systems of self-measurement of blood pressure, the OMRON HEM-705 CP and OMRON M1 (HEM 422C2-E) models]. Aten Primaria. 2002;30(1):22-8.
19. Roth M, Huppert FA, Mountjoy CQ, Tym E. The Cambridge examination for mental disorder of the elderly: revised. Cambridge: Cambridge University Press; 1998.
20. Paradela EM. Adaptação transcultural para o português do Teste Cognitivo de Cambridge (CAMCOG-R) e desempenho do teste em idosos ambulatoriais [tese]. Rio de Janeiro: Instituto de Medicina Social; 2007.
21. Tombaugh TN. Trail making test A and B: normative data stratified by age and education. Arch Clin Neuropsychol. 2004;19(2):203-14.
22. Malloy-Diniz LF, Lasmar VA, Gazinelli Lde S, Fuentes D, Salgado JV. The Rey Auditory-Verbal Learning Test: applicability for the Brazilian elderly population. Rev Bras Psiquatr. 2007;29(4):324-9.
23. Cunha, JA. Manual da versão em português da escala Beck. São Paulo: Casa do Psicólogo; 2001.
24. Nunes PV, Diniz BS, Radanovic M, Abreu ID, Borelli DT, Yassuda MS, et al. Camcog as a screening tool for diagnosis of mild cognitive impairment and

dementia in a Brazilian clinical sample of moderate to high education. Int J Geriatr Psychiatry. 2008;23(11):1127-33.

25. Kühnast C, Neuhäuser M. A note on the use of the non-parametric Wilcoxon-Mann-Whitney test in the analysis of medical studies. Ger Med Sci. 2008;6:Doc02.

26. Elias PK, Elias MF, Robbins MA, Budge MM. Blood pressure-related cognitive decline does age make a difference? Hypertension. 2004;44(5):631-6.

27. Daffner KR. Promoting successful cognitive aging: a comprehensive review. J Alzheimers Dis. 2010;19(4):1101-22.

28. Posner HB, Tang MX, Luchsinger J, Lantigua R, Stern Y, Mayeux R. The relationship of hypertension in the elderly to AD, vascular dementia, and cognitive function. Neurology. 2002;58(8):1175-81.

29. Söderlund H, Nyberg L, Adolfsson R, Nilsson LG, Launer LJ. High prevalence of white matter hyperintensities in normal aging: relation to blood pressure and cognition. Cortex. 2003;39(4-5):1093-105.

30. Mahmudi MJ, Hedayat M, Sharifi F, Edalat B, Mirarefin M, Ghaderpanahi M, et al. The association between high blood pressure and cognitive impairment in elderly: a brief report. Tehran University Medical Journal. 2012;69(12):793-8.

31. Guo Z, Fratiglioni L, Winblad B, Viitanen M. Blood pressure and performance on the Mini-Mental State examination in the very old: cross-sectional and longitudinal data from the Kungsholmen Project. Am J Epidemiol. 1997;145(12):1106-13.

32. Heims HC, Critchley HD, Martin NH, Jager HR, Mathias CJ, Cipolotti L. Cognitive functioning in orthostatic hypotension due to pure autonomic failure. Clin Auton Res. 2006;16(2):113-20.

33. Kitagawa K, Oku N, Kimura Y, Yagita Y, Sakaguchi M, Hatazawa J, et al. Relationship between cerebral blood flow and later cognitive decline in hypertensive patients with cerebral small vessel disease. Hypertens Res. 2009;32(9):816-20.

34. Paradela EM, Lopes CS, Lourenço RA. Adaptação para o português do Cambridge Cognitive Examination-Revised aplicado em um ambulatório publico de geriatria. Cad Saúde Publica. 2009;25(12):2562-70.

35. Ávila R, Bottino CM. Atualização sobre alterações cognitivas em idosos com síndrome depressiva. Rev Bras Psiquiatr. 2006;28(4):316-20.

36. Vicario A, Martinez CD, Baretto D, Casale AD, Nicolosi L. Hipertension and cognitive decline: impact on executive function. J Clin Hypertens (Greenwich). 2005;7(10):598-604.