ORIGINAL RESEARCH

The Association Between the Duration, Treatment, Control of Hypertension and Lifestyle Risk Factors in Middle-Aged and Elderly Patients with Mild Cognitive Impairment: A Case-Control Study

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Background: Epidemiological studies suggest that the incidence of hypertension in China is causally related to cognitive impairment. However, there is a dearth of information available regarding important factors for the association, including disease duration, therapeutic options, and risk factors associated with mild cognitive impairment (MCI) in patients with hypertension.
Methods: We selected a diverse cohort of 572 patients with hypertension and assessed cognitive function using MoCA. Potential risk factors were investigated by a structured questionnaire. Risk factors associated with the hypertension-induced MCI occurring conversion of were analyzed using multifactorial regression analysis.
Results: MCI was observed in 256 of 572 individuals, which increased with age (OR=1.15, 95% CI 1.10–1.20), but was decreased with high education status (OR=0.47, 95% CI 0.32–0.71). Risk factors independently associated with MCI were diabetes (OR=2.40, 95% CI 1.53–3.76), hyperlipidemia (OR=1.49, 95%=1.01–2.16), high salt diet (OR=2.27, 95% CI 1.34–3.84), and physical activity: >2h/week (OR=0.65, 95%0.44–0.94). However, controlling blood pressure to "normal" target values helped decrease the incidence of MCI (OR=0.44, 95% CI 0.30–0.65): this was not age dependent.
Conclusion: Our results suggest that it is necessary to promote the education of the middle-aged and elderly Chinese population to correctly and effectively use anti-hypertensives to control hypertension to a normal range to prevent cognitive.
Keywords: hypertension, mild cognitive impairment, control, risk factors

Introduction

In the aging Chinese population there is an increased prevalence of hypertension. Currently, it is estimated that there are 240 million hypertension patients 18 years and older in China,[1] and it has become a major public health concern.

Hypertension can cause not only serious complications such as stroke, heart failure, cardiovascular events but also cognitive impairment.[2] There is growing epidemiological and mechanistic evidence that hypertension is also an important risk factor for dementia, Alzheimer's disease, and MCI, and mild cognitive impairment (MCI).[3–6] According to a national epidemiological survey, hypertension increases the risk of dementia and MCI by 1.86 and 1.62 times, respectively.[7] Individuals with MCI are at a higher risk of progressing to dementia, particularly in the elderly population.[8] Dementia adversely the patient's ability to live and socialize, and is a burden on the economy, family, and society.[9] Even though HOPE-3 reported that antihypertensive therapy did not significantly reduce the risk of MCI or

dementia,[10] there remains some controversy regarding hypertension control and MCI incidence, especially in the elderly.[11]

The current study assessed cognitive function of hypertension patients between 50 and 75 years of age in Nanjing, China. We evaluated risk factors for developing MCI to determine whether anti-hypertensives affected cognitive function. The results may inform on therapeutic strategies to treat hypertension and associated MCI.

Patients and Methods
Study Population
Data study was collected 50 to 75 years old patients diagnosed with hypertension in the Affiliated Hospital of Nanjing University of Chinese Medicine, Zhimaying Community Health Service Center, Zhonghuamen Community Health Service Center, Confucius Temple Community Health Service Center, and Chaotiangong Community Health Service Center between May 2017 to October 2020. The study was approved by the Ethics Committee of the Affiliated Hospital of Nanjing University of Chinese Medicine (2018NL-080-03). This study was conducted in accordance with the Declaration of Helsinki. Informed written consent was obtained from all patients or their families. In this study, patients with non-essential hypertension, severe visual and hearing impairment, Alzheimer's disease, or other causes of dementia, heart failure, and stroke were excluded. Figure 1 presents a flow chart for patient inclusion and exclusion.

Data Collection
Each participant completed a standardized questionnaire via a face-to-face interview. Data collected included age, gender, occupation, education, BMI, medical history related to hypertension, diabetes mellitus, white matter hyperintensity, coronary artery disease, hyperlipidemia, and treatment data, and lifestyles choices including dietary preferences, smoke, drinking alcohol, physical activity, hobbies, sleep duration. The BMI of all patients was classified into four categories according to Chinese adult standards: underweight (BMI < 18.5), normal weight ($18.5 \leq$ BMI < 24.0), overweight ($24.0 \leq$ BMI < 28.0), or obesity (BMI $\geq$ 28.0).[12]
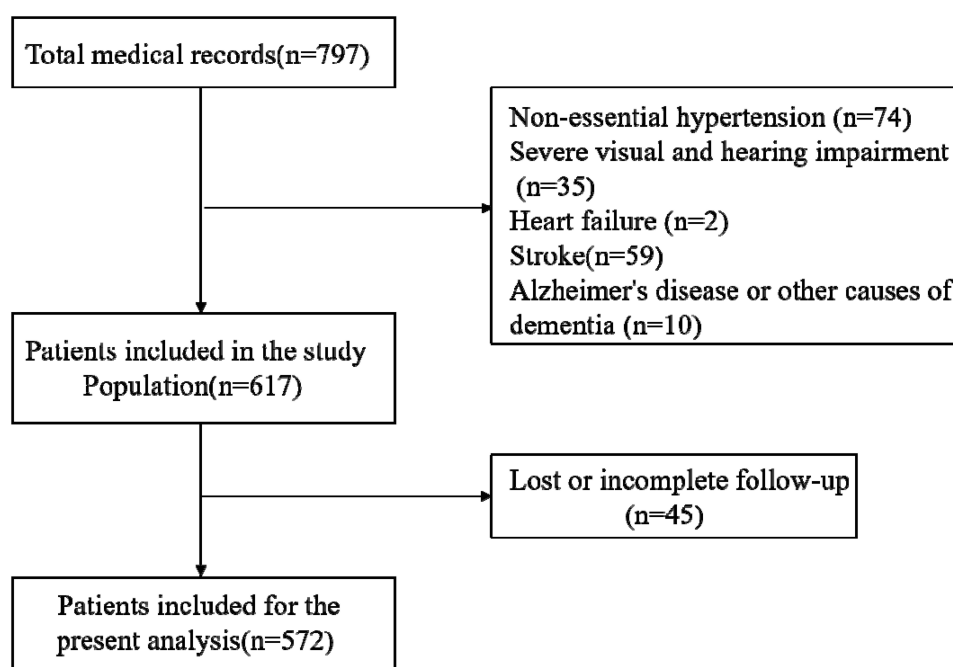
Figure 1 Screen flow chart of the study patients.

Definition and Grade of Essential Hypertension

Following the Chinese guidelines for the management of hypertension,[13] essential hypertension is a cardiovascular syndrome in which the underlying cause of the elevated blood pressure cannot be detected during the examination (not caused by complications of other diseases), and the main manifestation is elevated arterial pressure in the body circulation (systolic blood pressure ≥ 140 mmHg or diastolic blood pressure ≥ 90 mmHg).

Hypertension is graded as: Grade 1: SBP 140~159mmHg or DBP 90~99mmHg; Grade 2: SBP 160~179mmHg or DBP 100~109mmHg; Grade 3: SBP ≥180mmHg or DBP ≥110mmHg.

Neuropsychological and MRI Assessment

Trained neurologists evaluated each participant's cognitive function with the Chinese version of the Montreal Cognitive Assessment (MoCA-Chinese Beijing version) scale, which is commonly used measurement.[14] For MCI diagnosis, the patient should report cognitive decline, and diagnosis should meet the 2011 NIA-AA requirements.[15] Diagnosis included altered cognitive function, cognitive impairment involving one or more cognitive domains, maintained functional independence, and the ability to perform daily living. The sensitivity of MoCA is preferred to that of Mini-Mental Status Exam (MMSE).[16] Mild cognitive impairment (MCI) was defined as 18≤MoCA <26.[17,18] Patients with no more than 6-years of education have 1 point added to the total score.[19] All subjects underwent MRI on a device with a 1.5-T magnet. MRI (magnetic resonance imaging, which was used to estimate the severity of WMH (white matter hyperintensity) and the potential for stroke. All hypertension patients were divided into the MCI group and the non-MCI group.

When values were missing in the data survey, the questionnaires with vacancy rate ≥ 5% were invalidated; the questionnaires with vacancy rate < 5% were filled with the mean value.

Statistical Analysis

Continuous variables were expressed as the mean ± standard deviation if they followed a normal distribution, otherwise they were expressed as the median (interquartile range). Categorical variables were expressed as frequencies (percentages). As appropriate, one-way analysis of variance or the Kruskal–Wallis test was used to compare continuous variables. Categorical variables were compared using χ^2 test or Fisher's exact test, as appropriate. Univariate analysis was performed with the Student's t-test, Mann–Whitney U-test, or Chi-square test. Variables with $P<0.05$ in univariate analysis were then included in the forward stepwise logistic regression model.

Results

Description of the Population

A total of 572 patients, 307 male and 265 females, with essential hypertension were included in the present study. The total mean MoCA score was 25.03 ± 3.72 (median 26), and 44.76% (n= 256) of study participants scored below the recommended cut-off for MCI or dementia (<26 points). The distribution of the MoCA score is shown in Figure 2. Baseline characteristics of the two groups are shown in Table 1. The mean age of the participants was 61.31±4.74 years, ranging from 50 to 75 years, and 49.48% of them (n=283) were workers by occupation. Compared with the non-MCI group, patients in the MCI group were older, had a lower level of education, and a higher weight/BMI.

Analysis of Risk Factors for MCI

According to univariate analysis (Table 2), age, education, BMI, cigarette smoking, physical activity, sleep duration, food preferences, WMH, diabetes mellitus, hyperlipidemia, regular medication, controlled hypertensives, and hypertension grade (grade III) were significantly different between MCI group and non-MCI group ($P<0.05$). To reduce the effect of confounding factors, we further performed a multivariable analysis with or without the occurrence of MCI as a dependent variable (occurrence =1, not occurrence =0). Variables with $P<0.05$ in univariate analysis as the independent variables were included. Logistic stepwise regression analysis showed that age (OR: 1.15, 95% CI: 1.10–1.20), education (OR: 0.47, 95% CI: 0.32–0.71), physical activity (OR: 0.65, 95% CI: 0.44–0.94), food preferences (OR: 2.27, 95% CI: 1.34–
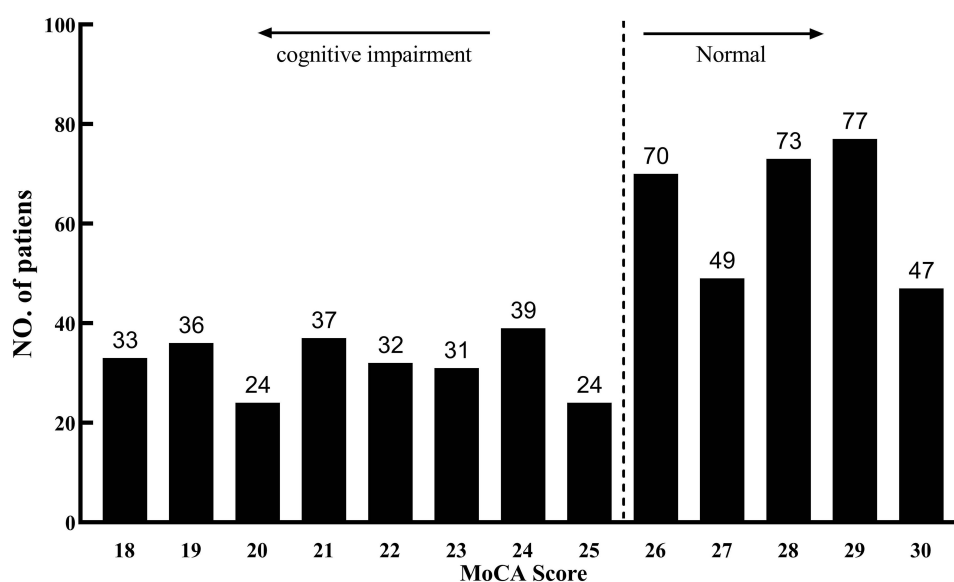
Figure 2 The distribution of MoCA score among 572 patients with hypertension.

3.84), diabetes mellitus (OR: 2.40, 95% CI: 1.53–3.76), hyperlipidemia (OR: 1.49, 95% CI: 1.01–2.16), controlled hypertensives (OR: 0.44, 95% CI: 0.30–0.65), and hypertension grade (OR: 6.13, 95% CI: 1.47–25.52) were independent risk factors for MCI in hypertensive patients with adjustment for other covariates with $P < 0.05$ in the univariable analysis.

The probability test outcome variable for predicting MCI was generated based upon a multivariable logistic regression data model, and it was plotted as an ROC curve to predict MCI outcomes. The area under the ROC curve was 0.772, which was between 0.7 and 0.9, showing that the model had a good predictive value (P-value <0.001, 95% CI: 0.734–0.810).

Relationship Between Hypertension Treatment Status and MCI

Table 3 shows the association of risk factors between duration, regular antihypertensive medication, hypertension control, and the prevalence of MCI by gender. Data was adjusted for age, education, physical activity, food preferences, diabetes mellitus, hyperlipidemia, controlled hypertensives, and hypertension grade. The duration of hypertension and the regular use of anti-hypertensive drugs did not significantly change the prevalence of MCI in either male or female participants. However, the difference between controlled hypertensive patients who achieved their treatment goal was significant. In male and female hypertensive patients, the adjusted OR (95% CI) of having MCI in those participants was 0.47 (0.28–0.79) and 0.40 (0.22–0.73).

Table 4 shows adjusted variables between the duration, regular antihypertensive medication, and control of hypertension, and the prevalence of MCI by age. In the older the group, a lower percentage of patients taking antihypertensive medications regularly achieved blood pressure control (p>0.05). In the 58–65 age group (n=351), the adjusted OR (95% CI) of having MCI was 0.40 (0.25–0.66) in those controlled with hypertensives compared with uncontrolled individuals. However, there was no difference in the prevalence of MCI among patients regularly using antihypertensives, compared to those who did not take medication regularly. There were no age-related differences, between 50–57 years and ≥65 years.

Discussion

The risk of developing MCI in hypertensive patients was influenced by several factors. After adjusting for confounding factors, we found that in the younger elderly population, hypertension control to a "normal" target significantly reduced the incidence of MCI.

Table I Baseline Characteristics According to Mild Cognitive Impairment Groups

Variable	Total (n=572)	Non-MCI Group (n=316)	MCI Group (n=256)	$t/x^2/Z$	p-value
Demographic data					
Age (Mean, SD), year	61.31(4.74)	59.91(4.55)	63.04(4.38)	−8.298	<0.001
Gender: Female, n (%)	265(46.33)	150(47.47)	115(44.92)	0.369	0.544
Education:≥8y, n (%)	208(36.36)	142(44.93)	66(25.78)	22.426	<0.01
BMI, n (%)				12.235	0.007
Underweight	11(1.92)	2(0.63)	9(3.52)		
Normal	331(57.87)	199(62.98)	132(51.56)		
Overweight	203(35.49)	103(32.60)	100(39.06)		
Obesity	27(4.72)	12(3.80)	15(5.86)		
Occupation, n (%)				9.671	0.085
Wokers	283(49.48)	154(48.73)	129(50.39)		
Farmers	84(14.69)	46(14.56)	38(14.84)		
Teachers and doctors	47(8.22)	34(10.76)	13(5.08)		
Civil servants	50(8.74)	31(9.81)	19(7.42)		
Business	67(11.71)	33(10.44)	34(13.28)		
Unemployed	41(7.17)	18(5.70)	23(8.98)		
Living conditions					
Cigarette smoking, n (%)	200(34.97)	98(31.01)	102(39.84)	4.850	0.028
Drinking alcohol, n (%)	213(37.24)	110(34.81)	103(40.23)	1.780	0.182
Drink tea, n (%)	241(42.13)	136(43.04)	105(41.02)	0.237	0.626
Physical activity:>2h/wk, n (%)	290(50.70)	174(55.06)	116(45.31)	5.380	0.020
Hobbies, n (%)	462(80.77)	256(81.01)	206(80.47)	0.027	0.870
Sleep duration, n (%) <6h/day	273(47.73)	139(43.99)	134(52.34)	3.961	0.047
Food preferences, n (%)				12.035	0.002
Light	140(24.48)	91(28.80)	49(19.14)		
General	248(43.36)	126(39.87)	110(42.97)		
Salty	149(26.05)	74(23.42)	87(33.98)		
Sweet	35(6.12)	25(7.91)	10(3.91)		
Medical history					
Diabetes, n (%)	132(23.08)	55(17.41)	77(30.08)	12.769	<0.001
Hyperlipidemia, n (%)	241(42.13)	119(37.66)	122(47.66)	5.798	0.016
Atherosclerosis, n (%)	417(72.90)	226(71.52)	191(74.61)	0.684	0.408
WMH, n (%)	248(43.36)	124(39.24)	124(48.44)	4.872	0.027
DOH:MD (IQR), year	7 (5)	7 (5)	7 (6)	0.550	0.511
Regular antihypertensive medication	380(66.43)	229(72.47)	151(58.94)	11.531	<0.001
Controlled hypertensives	237(41.43)	156(49.37)	81(31.64)	18.314	<0.001
Hypertension grade, n (%)				10.159	0.006
I	249(43.53)	149(47.15)	100(39.06)		
II	308(53.85)	164(51.90)	144(56.25)		
III	15(2.62)	3(0.95)	12(4.69)		
Types of antihypertensive drugs, n (%)				8.378	0.079
CCB	166(29.02)	104(32.91)	62(24.22)		
ACEI/ARB	257(44.93)	128(40.51)	129(50.39)		
ACEI/ARB+CCB	96(16.78)	51(16.14)	45(17.58)		
BB	37(6.47)	22(6.96)	15(5.86)		
Else	16(2.80)	11(3.48)	5(1.95)		

Abbreviations: SD, standard deviation; IQR, interquartile range; BMI, body mass index; WMH, white matter hyperintensities; DOH, duration of hypertension; CCB, calcium Channel Blockers; ACEI, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; BB, Beta-receptor blocker.

Table 2 Univariate and Stepwise Multivariate Logic Analysis of Risk Factors for MCI

Variables	Univariate		Multivariate*	
	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value
Age	1.17 (1.12–1.22)	<0.001	1.15 (1.10–1.20)	<0.001
Gender	0.90 (0.65–1.26)	0.544		
Education:≥8y	0.43 (0.30–0.61)	<0.001	0.47 (0.32–0.71)	<0.001
BMI				
Underweight	6.78 (1.44–31.89)	0.015	3.33 (0.61–18.12)	0.163
Normal	Reference		Reference	
Overweight	1.46 (1.03–2.08)	0.034	1.15 (0.72–1.83)	0.555
Obesity	1.88 (0.86–4.15)	0.116	1.16 (0.46–2.94)	0.754
Cigarette smoking	1.47 (1.04–2.08)	0.028	1.42 (0.96–2.11)	0.08
Drinking alcohol	1.26 (0.90–1.77)	0.182		
Physical activity:>2h/wk	0.68 (0.49–0.94)	0.021	0.65 (0.44–0.94)	0.021
Sleep duration, n (%) <6h/day	0.72 (0.51–0.99)	0.047	0.86 (0.59–1.26)	0.453
Food preferences				
Light	Reference		Reference	
General	1.62 (1.05–2.50)	0.028	1.35 (0.83–2.19)	0.223
Salty	2.18 (1.37–3.48)	0.001	2.27 (1.34–3.84)	0.002
Sweet	0.74 (0.33–1.67)	0.473	0.89 (0.36–2.18)	0.798
WMH	1.46 (1.04–2.03)	0.028	1.08 (0.74–1.58)	0.702
DOH	0.99 (0.96–1.03)	0.744		
Diabetes mellitus	2.24 (1.50–3.34)	0.001	2.40 (1.53–3.76)	<0.001
Hyperlipidemia	1.51 (1.08–2.11)	0.016	1.49 (1.01–2.16)	0.044
Regular antihypertensive medication	0.55 (0.39–0.78)	0.001	0.73 (0.45–1.16)	0.185
Controlled hypertensives	0.48 (0.34–0.67)	<0.001	0.44 (0.30–0.65)	<0.001
Hypertension grade				
I	Reference		Reference	
II	1.31 (0.93–1.84)	0.119	1.29 (0.88–1.90)	0.193
III	5.96 (1.64–21.66)	0.007	6.13 (1.47–25.52)	0.013

Notes: *Adjusted with *P* < 0.05 in the univariable analysis age, education, BMI, physical activity, cigarette smoking, drinking alcohol, sleep duration, food preferences, WMH, diabetes mellitus, hyperlipidemia, regular medication, controlled hypertensives and hypertension grade.

Research on hypertension and cognitive impairment first began in the 1960s with the study of pilots.[20] Several studies found that chronic hypertension, especially high SBP in middle age (40–65 years), was associated with an increased risk of cognitive impairment or dementia in later life.[2,21,22] However, studies on the relationship between blood pressure levels and cognitive decline or dementia in the elderly have been mixed, and inconclusive. One study reported that hypertension in the elderly was not related to cognitive impairment.[23] Some studies have even suggested that higher blood pressure levels are associated with better cognitive function scores in the elderly.[24] Hajjar[25] suggested that arterial stiffness may partially explain the link between blood pressure and cognitive decline.

In the present study, MCI occurred in about 44.8% of hypertensive patients, and we found no significant difference in the prevalence of MCI with age groups, between 50–57, 58–65, and >65 age groups. Interestingly, the prevalence of MCI in adults aged ≥60 years in China was 15.5% in 2020;[7] this is significantly lower than the hypertensive patients in this study (44.8%). Our findings suggest that hypertension may increase the onset of MCI in middle-aged and older adults, and grade 3 hypertension patients were more likely to have cognitive impairment than grade 1 hypertension patients.

Structural changes in cerebral vasculature secondary to long-term hypertension, with endothelial damage, may lead to altered cerebral perfusion. This is a main hypothesis linking hypertension to cognitive impairment.[26,27] Hypertension can cause dysfunction of neural circuits, such as the pulvinar nucleus of the thalamus[28] and prefrontal-limbic neural

Table 3 Association Between the Duration, Treatment and Control of Hypertension and the Prevalence of MCI by Gender

Prevalence of MCI	n,%/ MD (IQR)	Adjusted* OR (95% CI)	P value
Male	307(100)		
Duration of hypertension, year	7(5)	0.98(0.93–1.05)	0.622
Irregular antihypertensive meditation	113(36.8)	Reference	
Regular antihypertensive meditation	194(63.2)	1.04(0.62–1.77)	0.873
Uncontrolled hypertensives	179(58.3)	Reference	
Controlled hypertensives	128(41.7)	0.47(0.28–0.79)	0.005
Female	265(100)		
Duration of hypertension	8 (5)	0.96 (0.90–1.02)	0.179
Irregular antihypertensive meditation	79(29.8)	Reference	
Regular antihypertensive meditation	186(70.2)	1.01(0.54–1.92)	0.966
Uncontrolled hypertensives	156(58.9)	Reference	
Controlled hypertensives	109(41.1)	0.40(0.22–0.73)	0.003

Note: *Adjusted for age, education, physical activity, food preferences, diabetes mellitus, hyperlipidemia, controlled hypertensives and hypertension grade.

Table 4 Association Between the Duration, Treatment and Control of Hypertension and the Prevalence of MCI by Age

Prevalence of MCI	n,%/ MD (IQR)	Adjusted* OR (95% CI)	P value
50–57 years	117 (100)		
Duration of hypertension, years	6 (4)	0.96 (0.74–1.09)	0.516
Irregular antihypertensive meditation	24 (20.5)	Reference	
Regular antihypertensive meditation	93 (79.5)	1.82 (0.52–6.30)	0.348
Uncontrolled hypertensives	60 (51.3)	Reference	
Controlled hypertensives	57 (48.7)	0.55 (0.20–1.53)	0.253
58–65 years	351 (100)		
Duration of hypertension, years	7 (5)	0.96 (0.90–1.01)	0.119
Irregular antihypertensive meditation	126 (35.9)	Reference	
Regular antihypertensive meditation	225 (64.1)	0.97 (0.59–1.61)	0.919
Uncontrolled hypertensives	205 (58.4)	Reference	
Controlled hypertensives	146 (41.6)	0.40 (0.25–0.66)	<0.001
>65 years	104 (100)		
Duration of hypertension, years	10 (7)	1.01 (0.93–1.09)	0.807
Irregular antihypertensive meditation	42 (40.4)	Reference	
Regular antihypertensive meditation	62 (59.6)	0.78 (0.28–2.16)	0.625
Uncontrolled hypertensives	71 (68.3)	Reference	
Controlled hypertensives	33 (31.7)	0.58 (0.21–1.62)	0.3

Note: *Adjusted for age, education, physical activity, food preferences, diabetes mellitus, hyperlipidemia, controlled hypertensives and hypertension grade.

pathways.[29] The pulvinar is mutually and extensively connected with the prefrontal cortex, sensory cortex, superior colliculus and amygdala, and plays very important roles in contextual multi-sensory and cognitive processing.[30,31] Once the pulvinar is activated, this in turn is expected to lead to enhance symptoms of anxiety, depression, hypertension, and cognitive impairment.[28]

Antihypertensive treatment is crucial to control a serious of biological and pathological process linking hypertension and neuronal function. A Brazilian study reported that effective treatment of hypertension at any age could prevent or slow cognitive decline.[32] In 2020, a meta-analysis that included six prospective studies (containing 31,090 participants) showed that receiving antihypertensive therapy reduced the risk of cognitive impairment by 12% and the risk of

Alzheimer's disease by 16% compared with patients not receiving antihypertensive therapy; this effect was independent of the type of antihypertensive drugs.[33] However, Chang et al showed that antihypertensive treatment did not decrease the risk of cognitive decline.[34] Clearly, to definitively claim that antihypertensive drugs are effective not only at controlling hypertension but also at reducing MCI, there is a need for additional unbiased reproducible clinical studies in this area of research.

The present study found that the two key ORs for the prevention of MCI: patients on regular hypertension medication compared with those not on regular hypertension medication, and patients with controlled hypertension compared with uncontrolled hypertension were similar in the univariate analysis. However, in multivariate regression analysis, we found that the prevalence of MCI was significantly lower in patients with hypertension who reached the treatment target, than in those who did not, although they were taking antihypertensive drugs regularly. The results suggest that hypertension treatment has a protective effect on MCI, but treatment targets (blood pressure level) need to be met, and this effect was not statistically significant across different classes of antihypertensive agents (ACEI, ARB, β-blockers, CCB, and else).

In addition, many complex factors may be involved in the poor cognitive performance in hypertension patients, since hypertension is usually associated with other risk factors, such as diabetes and hyperlipidemia. Diabetes can lead to abnormal cerebral angiogenesis and increased capillary density in the central nervous system, which may accelerate damage and blood vessels leakage during neurodegeneration processes.[35] Ryuno et al found that patients with hypertension and diabetes were more likely to have cognitive decline compared to either alone,[36] which is similar to our findings. Hyperlipidemia can cause chronic inflammation of the nervous system, damage nerve cells, impair the function of vascular endothelial cells, and affect cognitive function.[37] In this study, the prevalence of MCI in patients with hyperlipidemia was 1.49 times higher than in patients without hyperlipidemia. However, this is another area of controversy. The relationship between blood lipids and MCI is still divided, with some researchers suggesting that elevated blood lipids have beneficial effects on cognitive function in the elderly population.[38,39] Future studies should focus on the interaction of multiple risk factors with a more extended follow-up period.

In terms of personal life, we also identified factors associated with the development of MCI in hypertension patients. Langa et al found that as education levels increased, the prevalence of cognitive impairment in the aged> 70 decreased from 12.2% in 1993 to 8.7% in 2002.[40] This study suggests that cognitive stimulation can prevent MCI. The salt intake of Chinese residents is one of the highest globally. The average daily intake of salt for adults has been above 10 grams for the past 40 years, more than twice the recommended amount.[41] Excessive salt intake can directly cause hypertension, which could lead to cognitive decline,[42] and reduces blood flow to the brain and lead to dementia.[43] Khater et al[44] confirmed that a good diet maintains good cognitive health, and the Mediterranean dietary pattern has a beneficial cognitive protective effect.[45] It is known that regular physical activity is positively correlated with cognitive function in patients with hypertension or in the normal population. However, which type of physical activity will be effective in preventing cognitive impairment in patients with hypertension has not been confirmed by authoritative studies. However, a meta-analysis demonstrated that maintaining physical activity in hypertensive patients helped improve cognitive function scores,[46] and brisk walking for 40 minutes three times per week reduces brain atrophy, improves memory, and other cognitive functions.[47] More research is needed in the future to individualize the type, frequency, and duration of physical exercise.

There are limitations to this study. First, there may be recall bias in the collection of patients data (eg, disease histories), as each piece of information was self-reported by the patient. To avoid such problems, we asked participants to bring historical medical paperwork and let their relatives join in the conversation, if possible. Second, changes in MoCA scores over time were not studied. If differences in MoCA were not related to hypertension, the ability to identify specific risk factors (eg, treatment for hypertension) would be reduced. Third, specific dietary and blood pressure variances were not collected from participants. The factors may be essential covariates in the analysis of the study. Fourth, the relationship between hypertension and cognitive function is complicated. Middle-aged and elderly patients often have an exceptionally high number of risk factors, such as coronary heart disease, depression, and insomnia. We attempted to adjust for confounding variables in our analysis, but it is possible that there may be other undetected covariates that are not reflected by the study results. Fifth, the present study may have been subject to misclassification bias. Some patients may not have taken their antihypertensive medication on the morning of the study because some participants may have

had to fast on the day of the blood test. Their blood pressure may have been elevated on the study day, so the investigators would have misclassified them as patients with irregular medication or uncontrolled hypertension. Finally, Nanjing is a developed area in eastern China and the study results may not be generalizable to less economically developed areas in northwestern China. Further prospective studies with large nationwide sample sizes are needed to explore practical measures to prevent and treat MCI in China's middle-aged and elderly hypertensive population.

Conclusion

This study shows that patients with hypertension who regularly take hypertensive drugs and control their blood pressure to achieve treatment goals effectively prevent MCI. Educational level, physical exercise, dietary sodium load, diabetes, and hyperlipidemia are related to cognitive function in hypertensive patients. Our results suggest that it is necessary to promote the education of the middle-aged and elderly Chinese population to correctly and effectively use anti-hypertensives to control hypertension to a normal range to prevent cognitive.

Acknowledgments

Author Contributions

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current journal; gave final approval of the version to be published; and agree to be accountable for all aspects of the work.

Disclosure

The authors report no conflicts of interest in this work.

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