The Association of Age at Diagnosis of Hypertension with Cognitive Decline: the China Health and Retirement Longitudinal Study (CHARLS)

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AIM: This study investigated whether an individual's age at diagnosis of hypertension, which is associated with a decline in cognitive performance in the China Health and Retirement Longitudinal Study (CHARLS) participants.

METHODS: Our analysis was based on the CHARLS with baseline data collected between 2011 and 2018. We randomly selected a control participant for each hypertensive participant using propensity score. The cohort comprised 2413 individuals with hypertension and 2411 controls. Participants were divided into three groups as follows: non-hypertension, hypertension diagnose ≥55 years, and hypertension diagnose <55 years. Cognitive performance was measured in both visits and evaluated by the scores of the memory, executive function, and orientation and global cognitive.

RESULTS: After multivariable adjustment, individuals with hypertension diagnosed <55 years had a significantly faster cognitive decline in memory test (β (95% CI, −1.117 [−1.405, −0.83]), orientation test (β (95% CI, −1.273 [−1.348, −1.198]) and global cognitive (β (95% CI, −1.611 [−1.744, −1.478]) compared with the corresponding controls. A longer hypertension duration was associated with worse memory test (β (95% CI, −0.069 [−0.113 to −0.025]). Among treated individuals, blood pressure control at baseline was inversely associated with the decline in orientation test (β (95% CI, −0.659 [−0.939, −0.380]), orientation test (β (95% CI, −0.259[−0.365, −0.153])and global cognitive (β (95% CI, −0.124 [−0.162, −0.086]).

CONCLUSIONS: Our findings suggest that hypertension diagnosed in mid-life is associated with worse cognition compared to late life. Besides, longer duration of diagnosis is associated with worse memory test. In addition to hypertension, pressure control might be critical for the preservation of cognitive function.

KEY WORDS: blood pressure; hypertension; cognitive dysfunction.

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INTRODUCTION

It is estimated that the number of adults with hypertension worldwide was 1.4 billion in 2010 and may increase to 1.6 billion by 2025.[1] The latest epidemiological investigation in China showed that the hypertension prevalence in the old population was more than 20%.[2] Accumulating epidemiologic and mechanistic evidence suggests that hypertension is implicated in the occurrence of cognitive decline,[3,4] and is potentially preventable and treatable.[5–7] Although it is not known exactly when hypertension begins to affect cognition, findings from previous studies have shown middle age seems to be a sensitive period in which exposure to hypertension has a subtle negative impact on the brain more than hypertension started at older ages.[8–11] In addition, the use of antihypertensive medications[12,13] and control of stress levels[14] appear to moderate the association between high blood pressure and cognitive decline. Among Chinese adults, nearly half have hypertension, fewer than a third are being treated, and fewer than one in twelve are in control of their blood pressure.[2] National data on the association of age at diagnosis of hypertension with cognitive in China are scarce, and how hypertension awareness, treatment, and control rates vary geographically and across population subgroups affect the association is uncertain.

Studies investigating the association between hypertension duration and cognitive have yielded mixed results. Some studies have suggested an association between longer duration of hypertension and an increased risk of cognitive decline and dementia,[15,16] whereas others showed no association.[17] On the other hand, earlier onset of hypertension means longer duration of exposure to hypertension, regardless of age at onset of hypertension. Therefore, the shorter duration of hypertension may partly explain the inconsistency between studies examining the effects of hypertension on cognitive decline or dementia in older adults.[16] Given these conflicting results, age of diagnosis and duration of hypertension must be addressed.

A better understanding of the effect of age on the association of hypertension and the duration of hypertension is important for promoting cognitive health. Herein, using a population-based cohort, we sought to evaluate the association between age at diagnosis of hypertension at different stages of life-course, hypertension duration, control of hypertension, and cognitive function after an 8-year follow-up.

METHODS

Study Population

This study used data from waves 1 to 4 (2011 to 2018) of the China Health Retirement Longitudinal Study (CHARLS), a multicenter cohort of randomly selected Chinese residents aged 45 years or older from both urban and rural areas in 28 provinces. The data are available online at https://charls.pku.edu.cn/. The cohort was conformed to the Declaration of Helsinki and approved by the Peking University Institutional Review Board (IRB00001052-11015). Detailed information on the study was previously published.[18,19] All participants signed an informed consent.

As shown in Fig. 1, among the 17,708 participants interviewed in the baseline survey, a total of 11,868 individuals completed the three subsequent follow-ups. Wave 1 (2011) in the CHARLS was regarded as the baseline in the present study. One control for each individual with hypertension was randomly selected from those without hypertension at baseline using propensity score. Our propensity score accounted for age, sex, education, alcohol consumption, physical activity, smoking, body mass index, and depression (Fig. 1). Consistent with the previous studies,[20,21] individuals with average systolic blood pressure (SBP) < 140 mmHg and average diastolic blood pressure (DBP) < 90 mmHg and who did not use antihypertensive were classified as normal and hypertension was defined as (1) SBP ≥ 140 mmHg or average DBP ≥ 90mmHg, or (2) self-reported use of antihypertension agents (either chemical drugs or traditional Chinese herbal products) at the time of investigation. In addition, we excluded individuals because of (1) missing diagnosis age at hypertension (n=1532) and (2) missing date of birth (n=4).

Age at Diagnosis of Hypertension

Participants were asked whether they had ever been told by a doctor that they had hypertension. For those who reported a diagnosis of hypertension, they were requested to answer a further question "What was your age when hypertension was first diagnosed?" The following checks were performed: (1) reject if answer <0; (2) reject if answer >participant's age; (3) ask to confirm if the answer. The age of diagnosis was then categorized as (1) middle-age hypertension (<55 years) and (2) late hypertension (≥55 years). Duration of hypertension (visit 1 age-age of hypertension diagnosis) and analyzed as a continuous variable.

Blood Pressure

BP was measured using a validated oscillometric device (Omron HEM 705CPINT) on the right arm after a 5-min rest in a sitting position in a quiet, temperature-controlled room (20–24 °C). Three measurements were taken at 1-min intervals, and the means of the three measurements of SBP and DBP were used.

The effect of antihypertensive use per se on cognitive performance was evaluated on participants with hypertension diagnosis before study entry (N=2413) and grouped into control and uncontrol. The role of BP control was evaluated only in hypertensive individuals under treatment at visit 1 (N=1813) and categorized into controlled hypertension (SBP<140 mm Hg and DBP<90 mm Hg) and uncontrolled hypertension (SBP≥140 mm Hg or DBP≥90 mm Hg).

Cognitive Evaluation

Cognitive assessments were conducted in waves 1 to 4 in the CHARLS. Three cognitive domains were covered, including memory, executive function, and orientation. The first one is episodic memory through immediate and delayed recall. Ten unrelated Chinese words were read to each participant, and the memory ability was evaluated by counting how many words could be recalled immediately (immediate word recall) and 4 min later (delayed word recall). One point was given for each word recalled in either an immediate or a delayed recall task (0 to 20 points). Executive function was assessed by an intersecting pentagon copying test (0 or 3 points) and the Serial Sevens test (0 to 5 points) in the CHARLS (0 to 8 points in total). In the intersecting pentagon copying test, participants were asked to observe and then draw a picture of two overlapping pentagons. A successful drawing was given three points. In the Serial Sevens test, participants counted backwards from 100 by sevens for five times. One point was given for each correct answer. Orientation was evaluated by four questions on the year, the month, the date of the month, and the day of the week. The sum of correct answers was regarded as the orientation score (0 to 4 points). Both the validity and the reliability of these tests have been well documented.[22] To assess overall cognitive function, z-scores were generated for each cohort in two steps: step 1—normalize to baseline, generate domain z-score. Each range test score was subtracted from the mean and then divided by the standard deviation (SD) of the baseline scores. For example, in CHARLS, the mean and standard deviation of baseline executive function were 5.4 and 2.4, respectively. Then calculate the performer Z-score for each wave (original performer score—5.4)/2.4. Step 2—renormalize the mean of the three domains to the baseline and calculate the individual global z-scores in each wave. This method of generating cognitive z-scores is well established.[23–25]

Covariables

Sociodemographic characteristics included age, sex, and education. The health behaviors included cohabitation status, smoking (nonsmoker, ex-smoker, and smoker), leisure physical activity, sleep duration, and alcohol consumption. Cohabitation status was categorized as living alone or not. Once per week or a higher frequency of drinking was defined as alcohol consumption. Engaging in vigorous or moderate activities once weekly or more was regarded as physically active. Depressive symptoms were evaluated by an 8-item version of the

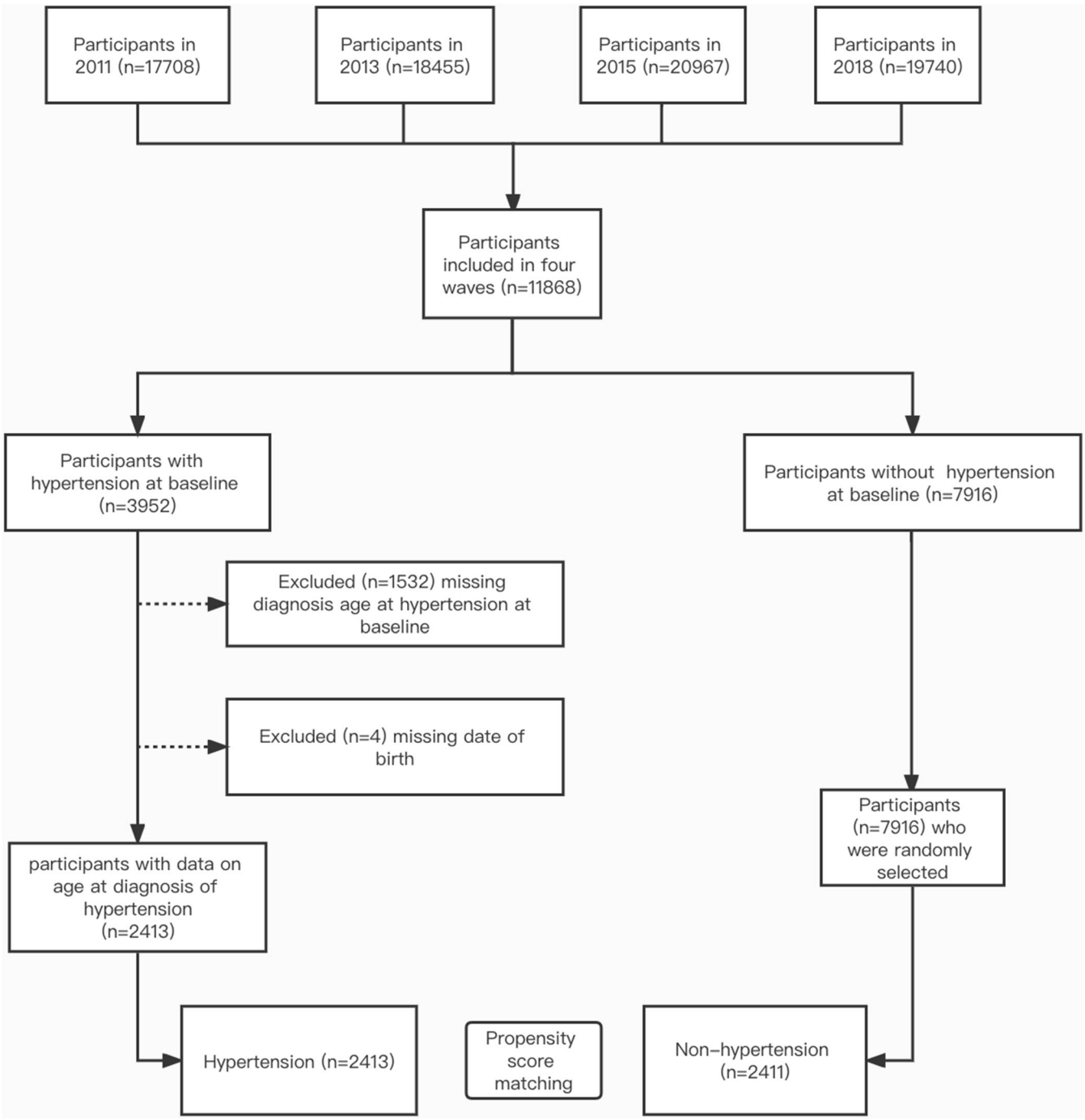

Fig. 1 Flowchart for population selection from the CHARLS. Propensity score matching was to select controls for hypertensive participants. Propensity score accounted for age, sex, education, alcohol consumption, physical activity, smoking, body mass index, and depression

Center for Epidemiologic Studies Depression a 10-item version of the CESD (CESD-10, 0 to 3 points for each item) in the CHARLS. Participants with a score of ≥ 12 in the CESD-10 were regarded as having depressive symptoms.[26,27]

Other potential confounders were body mass index (kg/m^2; continuous), and glycosylated hemoglobin (HbA1c) was measured using high-performance liquid chromatography on a Bio-Rad Variant II Turbo. Cholesterol, high-density lipoprotein (HDL-C), low-density lipoprotein (LDL-C), and triglycerides were measured by direct enzymatic methods (Konelab, Thermo Fisher Scientific, Waltham, MA), self-reported dyslipidemia, cancer or malignant tumor, chronic lung diseases, liver disease, heart problems, stroke, kidney disease, stomach or other digestive disease, emotional, nervous, or psychiatric problems, memory-related disease, arthritis or rheumatism, asthma, and diabetes (no/yes).

Statistical Analysis

Categorical variables were described as proportions and continuous variables, as medians and interquartile range, or as means and SD. Comparisons of continuous variables between groups were done using *t*-tests, one-way ANOVA, or equivalent non-parametric tests.

Generalized linear mixed model (GLMM) regression models with random intercept and slope were used to evaluate longitudinal changes in test performance between study visits 1 to 4.[28] The fixed effects (β) and variance components (α) of the generalized mixed linear models were estimated using maximum restricted likelihood methods. The pool function implements the rules for combining the separate estimates and SEs from each of the imputed datasets to provide an overall estimate with SEs, CIs, and *p* values.[29] Subgroup analyses were performed using stratified GLMM.

Missing values for categorical covariates were assigned as a single category. Missing values of quantitative data were not replaced because GLMM can accommodate missing data under the assumption that they are missing at random.

Univariate analyses and the generalized mixed model were done using SPSS (version 26.0), and all *p* were 2-sided with statistical significance set at <0.05.

RESULTS

Baseline Characteristics

Of 4824 participants included, 61.6% were female, mean age 68.3 (SD=9.5) years at visit 1. There was no significant difference in sex, duration of sleep, HbA1c, LDL-C, depression symptoms, pain, residence, and physically active between hypertensive participants and controls. Non-hypertensive participants had higher levels of current smokers and physically active than hypertensive participants (Table 1).

Table 1 Characteristics of the study population at the baseline (2011)

Baseline characteristics	Non-hypertension	Hypertension
Age	68.6 (9.2)	68.4 (9.3)
Sex (female)	1502 (62.3)	1470 (60.9)
Education		
Elementary school or below	1734 (71.9)	1713 (71.0)
Middle school	447 (18.5)	450 (18.7)
High school or above	231 (9.6)	249 (10.3)
BMI	23.7 (3.8)	25.0 (4.0)
HbA1c	5.3 (0.8)	5.4 (0.9)
LDL-C	118.1 (35.2)	118.2 (36.9)
HDL-C	50.1 (14.4)	48.2 (14.5)
Triglycerides	130.8 (83.7)	150.0 (105.6)
Total cholesterol	193.4 (39.6)	196 (39.3)
Depression symptom	2370 (98.3)	869 (36)
Pain		
Mild	213 (25.3)	214 (8.9)
Moderate	313 (37.1)	1841 (76.3)
Severe	318 (37.7)	357 (14.8)
Living alone	355 (14.7)	340 (14.1)
Live		
Rural	2096 (86.9)	2094 (86.8)
Town	316 (13.1)	318 (13.2)
Smoking		
Never smoker	0 (0)	1567 (65)*
Former smoker	695 (28.8)	252 (10.4)*
Current smoker	1717 (71.2)	593 (24.6)*
Alcohol consumption		
Do not use	1987 (82.4)	1991 (82.5)
Moderate	185 (7.7)	204 (8.5)
Excessive	240 (10)	217 (9)
Physically active	737 (30.6)	273 (11.3)*
Orientation	3.7 (0.4)	2.7 (1.4)
Memory	5.7 (4.1)	5.8 (3.9)
Executive	5.4 (2.5)	5.2 (2.4)

Data are mean (SD), or N (%). BMI body mass index, SBP systolic blood pressure, DBP diastolic blood pressure, HbA1c glycosylated hemoglobin, HDL-C high-density lipoprotein cholesterol, LDL-C low-density lipoprotein cholesterol

**Refers to significant difference between hypertensive participants and controls. T-test was used to test the difference of continuous variables between hypertensive participants and controls and χ^2 for categorical variables*

Age at Diagnosis of Hypertension and Cognitive Function

As shown in Table 2, compared with participants without hypertension, middle-age hypertension was associated with a sharper decline in the memory test (β (95% CI, −1.117 [−1.405, −0.83]), orientation test (β (95% CI, −1.273 [−1.348 −1.198])and global cognitive score (β (95% CI, −1.611 [−1.744, −1.478]), and late hypertension with a reduction in orientation test (β (95% CI, −1.015 [−1.095 −0.936])and global cognitive score (β (95% CI, −1.026 [−1.167, −0.886]). Longer duration of hypertension were independently associated with worse memory scores (β (95% CI, −0.069 [−0.113 to −0.025]).

Besides, hypertensive participants were categorized into their age at diagnosis: < 35 years, 35 to 45 years, 45 to 54 years, 55 to 64 years, and ≥ 65 years. Rate of cognitive decline accelerated with younger age at diagnosis when age was less than 55 years. However, when diagnosis age is higher than 55, rate of cognitive decline slowed down. Individuals with hypertension diagnosed at < 35 (β (95% CI, −1.565 [−1.655, −1.475]), 35 to 44 (β (95% CI, −1.114 [−1.194, −1.034]), 45 to 54 (β (95% CI, −1.036 [−1.118, −0.953]), 55 to 64 (β (95% CI, −0.908 [−1.025, −0.792]), and ≥ 65 years (β (95% CI, −1.105 [−1.341, −0.868]) had lower scores compared with the controls in orientation tests. And individuals with hypertension diagnosed at < 35 (β (95% CI, −2.131 [−2.290, −1.972]), 35 to 44 (β (95% CI, −1.307 [−1.448, −1.166]), 45 to 54 (β (95% CI, −1.065 [−1.210, −0.92]), 55 to 64 (β (95% CI, −0.742 [−0.929, −0.518]) and ≥ 65 years (β (95% CI, −1.448 [−1.865, −1.031]) in global cognitive score (shown in Table S1).

Hypertension Control and Cognitive Function

As depicted in Table 3, uncontrolled hypertension was an independent predictor of greater decline in memory test (β (95% CI, −0.659 [−0.939, −0.380]), orientation test (β (95% CI, −0.259 [−0.365, −0.153]), and global cognitive score (β (95% CI, −0.124 [−0.162, −0.086]) in compared to controlled hypertension. Furthermore, among treated hypertensive

Table 2 Association between age at diagnosis of hypertension and duration of hypertension at baseline and cognitive performance over 8 years of follow-up, estimated by GLMM

Cognitive function test	Memory	Executive function	Orientation	Global
	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)
Intercept	5.933 (5.608, 6.257)***	5.364(5.209 5.520)***	3.892(3.808 3.977)***	0.762(0.611 0.912)***
Age at diagnosis of hypertension				
Normal BP	Ref.	Ref.	Ref.	Ref.
Hypertension in middle age (<55years)	−1.117 (−1.405, −0.83)***	−0.029 (−0.169 0.111)	−1.273 (−1.348 −1.198)***	−1.611 (−1.744, −1.478)***
Late hypertension (≥55years)	−0.021 (−0.325, 0.282)	−0.082 (−0.214, 0.051)	−1.015 (−1.095 −0.936)***	−1.026 (−1.167, −0.886)***
Duration of exposure to hypertension	−0.069 (−0.113, −0.025)*	−0.031 (−0.072, 0.011)	0.008 (−0.002, 0.019)	0.002 (−0.006, 0.011)
Age†, year	−0.13 (−0.144, −0.115)*	0.011 (0.003, 0.019)*	−0.016 (−0.021, −0.011)*	−0.014 (−0.016, −0.011)*

Indicate (β)
BMI body mass index
****P value <0.001; **P value <0.01; *P value <0.05. CHARLS (N=4824)*
Final model adjusted for: age†, sex, education level, exposure time, SBP, DBP, BMI, HDL-C, triglycerides, living status, smoking, alcohol consumption, physical activity, dyslipidemia, diabetes, chronic lung diseases, stroke, memory-related disease, and use of antihypertension drugs
†Age, age at baseline + follow-up time

individuals, types of antihypertension drugs were not associated with longitudinal changes in cognitive performance (Table 4).

Subgroup Analysis

As shown in Table S2~5, the stratified analysis revealed a highly consistent pattern. Regardless of subgroup, the effect size of the association between age at diagnosis of hypertension and cognitive was stable. In the terms of female, middle-age hypertension was associated with a decline in the memory test (β (95% CI, −2.163 [−2.682, −1.697]), executive function (β (95% CI, 0.234 [0.017, 0.45]), orientation test (β (95% CI, −2.163 [−2.682, −1.697]), and global cognitive score (β (95% CI, −2.144 [−2.357, −1.931]), and late hypertension with a decline in the memory test (β (95% CI, −0.965 [−1.45, −0.48]), orientation test (β (95% CI, −1.355 [−1.484, −1.226]), and global cognitive score (β (95% CI, −1.444 [−1.665, −1.222]), while in male group, middle-age hypertension was associated with a decline in the memory test (β (95% CI, −0.651 [−1.053, −0.249]), executive function (β (95% CI, −0.169 [−0.362, −0.025]), orientation test (β (95% CI, −0.973 [−1.074, −0.872]), and global cognitive score (β (95% CI, −1.259 [−1.448, −1.070]), and late hypertension with a decline in the executive function (β (95% CI, −0.188 [−0.369, −0.007]), orientation test (β (95% CI, −0.837 [−0.944, −0.729]) and global cognitive score (β (95% CI, −0.865 [−1.066, −0.664]).

DISCUSSION

In this large cohort of middle-aged and older adults, hypertension in middle age predicted a reduction in the memory test, orientation test, and global cognitive score. Besides, duration of exposure to hypertension was associated with a decrease in the memory test. Individuals with uncontrolled hypertension had a sharper decline in the memory test, orientation test, and global cognitive score compared with the controlled subjects. Among treated hypertensive individuals, types of antihypertension drugs were not associated with longitudinal changes in cognitive performance. A stronger relationship between age at diagnosis of hypertension and cognitive was detected in female, elementary school or below, depression, living alone, and alcohol consumption.

Table 3 Association between hypertension uncontrol at baseline and cognitive performance over 8 years of follow-up, estimated by GLMM

Cognitive function test	Memory	Executive function	Orientation	Global
	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)
Intercept	10.825 (8.721, 12.929)***	5.615 (4.416, 6.815)***	2.383 (1.609, 3.156)***	0.487 (0.278, 0.695)***
Hypertension control status				
Controlled hypertension	Ref.	Ref.	Ref.	Ref.
Uncontrolled hypertension	−0.659 (−0.939, −0.380)***	0.06 (−0.103, 0.224)	−0.259 (−0.365, −0.153)***	−0.124 (−0.162, −0.086)***
Age†, year	−0.131 (−0.147, −0.115)***	0.005 (−0.002, 0.012)	−0.013 (−0.018, −0.009)***	−0.013 (−0.015, −0.011)***

Indicate (β)
BMI body mass index
****P value <0.001; **P value <0.01; *P value <0.05. CHARLS (N=1831)*
Final model adjusted for: age†, sex, education level, exposure time, SBP, DBP, BMI, HDL-C, triglycerides, living status, smoking, alcohol consumption, physical activity, dyslipidemia, diabetes, chronic lung diseases, stroke, memory-related disease, and use of antihypertension drugs
†Age, age at baseline + follow-up time
BMI body mass index

Table 4 Association between with taking Chinese traditional medicine and with taking western modern medicine at baseline and cognitive performance over 8 years of follow-up, estimated by GLMM

Cognitive function test	Memory	Executive function	Orientation	Global
	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)
Intercept	9.135 (6.689, 11.581)***	6.351 (4.922, 7.781)***	2.435 (1.510, 3.359)***	0.468 (0.077, 0.860)**
Types of antihypertension drugs				
Western modern medicine	Ref.	Ref.	Ref.	Ref.
Chinese traditional medicine	−0.039 (−0.235, 0.157)	0.112 (−0.002, 0.227)	0.005 (−0.069, 0.079)	0.013 (−0.019, 0.044)
Age†, year	−0.115 (−0.126, −0.104)***	0.004 (−0.003, 0.01)	−0.012 (−0.017, −0.008)***	−0.013 (−0.015, −0.011)***

Indicate (β)
BMI, body mass index
****P value <0.001; **P value <0.01; *P value <0.05. CHARLS (N=1831)*
Final model adjusted for: age†, sex, education level, exposure time, SBP, DBP, BMI, HDL-C, triglycerides, living status, smoking, alcohol consumption, physical activity, dyslipidemia, diabetes, chronic lung diseases, stroke, memory-related disease, and use of antihypertension drugs
†Age, age at baseline + follow-up time

This work utilized an extended model approach to adjust the potential confounders and performed subgroup and interaction analyses to ensure a stable relationship between age at diagnosis of hypertension and cognitive. Similar to previous findings,[13,30,31] our research shows that hypertension in middle age predicted a reduction in memory test, orientation test, and global cognitive score compared to the older age. Besides, hypertension has been associated with virtually all domains of cognitive function, but existing evidence suggest that hypertension does not equally affect distinct cognitive abilities over time.[8,32,33] This consistency further confirms the reliability and generality of our results. We found no association between hypertension and executive function, one of the most vulnerable domains to hypertension effects. However, a large cohort by De Menezes et al.[17] indicate only modest effects of hypertension at middle age on the memory decline. This discrepancy may be because their study population is much younger than ours, has a higher level of education, and has been followed up for a relatively short time. The high schooling of their cohort, due to mechanisms involving greater cognitive reserve, may contribute to better initial cognitive performance or delayed cognitive decline in the follow-up period,[34] hindering the ability to detect a more pronounced modifying effect of age of hypertension onset on cognitive decline in distinct abilities.

Because earlier age of hypertension onset generally implies a longer duration of exposure to hypertension, we analyzed these 2 components separately. Our results demonstrated an adverse effect of increased duration of hypertension on memory tests in the follow-up period. However, our results do not support an adverse effect of increased duration of hypertension on global cognitive performance, as reported by some studies.[35,36] The lack of association between duration of hypertension and global cognitive performance in our study is consistent with our findings about age of hypertension diagnosis: greater effect of hypertension at an older age hypertension at middle age in cognitive performance over 8-year follow-up.

Our findings help to further elucidate the potential benefits of blood pressure control on cognitive function, as memory, orientation, and global scores declined significantly faster in the uncontrolled hypertensive group than in the control group, in line with recently published finding.[37] Contrariwise, in our analysis, types of antihypertension drugs were not associated with longitudinal changes in cognitive performance. A randomized, multicenter, double-blind, noninferiority trial showed that the Songling Xuemaikang capsule—a Chinese herbal formula—was effective for essential hypertension,[38] which is inconsistent with our research. However, medical records were not available in CHARLS; thus, the use of self-reported measures may also have some degree of bias.

Our study has several limitations; we cannot rule out misclassifications of age of hypertension onset since it was self-reported by hypertensive individuals at baseline. Furthermore, our study population is relatively old; a potential cognitive benefit of higher BP levels in the elderly due to better brain perfusion, often present as a result of decompensated autoregulatory brain mechanisms, may hinder the analysis of the effect of hypertension onset at different ages on cognitive performance.[35,39] CHARLS did not perform a comprehensive screening to rule out cognitive impairment at entry, and stroke information was self-reported. In addition, our results cannot be extrapolated to unevaluated domains and abilities. Finally, we did not evaluate the causes of inadequate control of hypertension in CHARLS: low adherence to treatment, more severe form of hypertension, or more advanced stage of the disease. Although important, such analysis is beyond the scope of this study.

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Data Availability *The data used in the study are accessible to be downloaded publicly at https://charls.charlsdata.com/pages/data/111/zh-cn.html*

Declarations:

Ethics Approval: *The CHARLS were approved by the Peking University Institutional Review Board, respectively. All participants provided written informed consent.*

Ethics Approval: *The ethical approval of data collection was from the Biomedical Ethics Review Committee of Peking University (IRB00001052–11015). Every participant signed an informed consent before investigation, and their information were kept anonymous.*

Conflict of Interest: *The authors declare no conflict interests.*

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