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Prevalence, numbers and mortality risk of hypertensive patients with depressive symptom in China

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Abstract

Background China is currently grappling with the escalating burden of hypertension and depression. This study aimed to assess the prevalence and number of hypertensive patients with depressive symptom, and to evaluate their risk of all-cause mortality.

Methods Data from the China Health and Retirement Longitudinal Study (CHARLS) were utilized to estimate the prevalence of individuals with both hypertension and depressive symptom, the recommendation rate for antihypertensive medications, the blood pressure control rate, and the corresponding population size. The Cox proportional hazard model was employed to estimate the risk of all-cause mortality associated with hypertension combined with depressive symptom.

Results Overall, 15.01% (95% CI: 13.80, 16.31) of adults, corresponding to 72.06 million (95% CI: 66.91, 77.23) individuals, were identified as having both hypertension and depressive symptom. Among these, 28.49 million (95% CI: 27.07, 29.92) were recommended to initiate blood pressure medications but did not comply. Furthermore, 19.53 million (95% CI: 18.01, 21.06) hypertensive patients with depressive symptom who were taking antihypertensive medications did not achieve their blood pressure control goals. Hypertension combined with depressive symptom was associated with an increased risk of all-cause mortality (hazard ratio = 2.21, 95% CI: 1.48, 3.31).

Conclusions Our findings indicated a significant population of individuals with both hypertension and depressive symptom in China, with low treatment and control rates. The coexistence of hypertension and depression was linked to a heightened risk of all-cause mortality. Strategies for hypertension prevention and treatment should be integrated with considerations for depression.

Clinical trial number Not applicable.

Keywords Hypertension, Depression, All-cause mortality, Prevalence, Number

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Introduction

Hypertension, also known as high blood pressure, is a systemic disease based on vascular disease, with elevated blood pressure as the main manifestation [1]. Despite variations in the diagnostic criteria for hypertension globally, it remains a serious disease [2]. Prolonged high blood pressure can cause severe damage to organs such as the heart, brain, and kidneys, escalating the risk of hemorrhagic stroke, ischemic stroke, myocardial infarction, sudden death, heart failure, and even cognitive decline and dementia [3, 4]. Globally, it is estimated that hypertension causes about 10 million deaths each year [5]. Furthermore, a recent study indicates a substantial rise in the number of adults aged 30–79 with hypertension, soaring from 650 million to 1.28 billion over the past 30 years, with more than 700 million of them unaware their hypertensive condition and more of the increase living in low - and middle-income countries [6].

The correlation between hypertension and depression has emerged as a significant global public health concern, with depression contributing to the increase in cardiovascular disease [7, 8]. Hypertension represents a critical public health issue in China, which is not only the chronic noncommunicable disease with the largest number of cases, but also the primary modifiable risk factor linked to elevated cardiovascular disease and mortality in the population, and its prevalence is still on the rise [9]. However, the awareness rate, treatment rate and control rate for hypertension remain relatively low [10]. In addition, depression is an important public health challenge in China, ranking as the second leading cause of disability in the country [11]. The prevalence of depressive symptoms among adults aged over 50 is approximately 4.1% [12]. The association between hypertension and depression has also been recognized, and depression in hypertensive patients may affect their blood pressure levels and medication compliance, increasing the risk of cardiovascular disease [13, 14]. Additionally, depression is also an independent risk factor for stroke and cardiovascular events [15]. Anxiety and depression can heighten heart rate and blood pressure by activating the autonomic nervous system [16]. Study indicate that combination of antidepressants and antihypertensive drugs yields better results in reducing blood pressure among elderly patients with hypertension and depression compared to using antihypertensive drugs alone [17].

Several studies have evaluated the prevalence of hypertension and depression and their association with mortality [18–20]. However, these studies have some limitations. As far as we know, no studies have utilized nationally representative data to estimate the prevalence of hypertensive patients with depression or estimate their population size. Therefore, the current study aimed to estimate the number of hypertensive patients with depressive symptom and the number of candidates for initiation of antihypertensive therapy in China, as well as assessed their prognostic risk.

Methods

Study populations

Using baseline data from the China Health and Retirement Longitudinal Study (CHARLS) 2011–2012 (wave 1), the study described the percentage and number of hypertensive patients with or without depression and analyzed their treatment/control status. The CHARLS is a nationally representative longitudinal survey of Chinese people aged 45 years and older and their spouses, designed to assess the social, economic and health status of community residents. The survey aims to collect a high-quality, nationally representative sample of Chinese residents aged 45 and above. The profile of CHARLS has been previously reported [21] and, in short, it employs a multi-stage probability sampling with 17,708 respondents drawn from 150 county-level units. This study used 2011–2012 CHARLS National Baseline Survey data and 2013 follow-up data (wave 2). We used data from the CHARLS (National Baseline Survey, 2011) to estimate the population size. The CHARLS survey included a total of 17,708 participants and calculated a sample weight for each individual to estimate the national population size. We first excluded subjects who did not meet the inclusion criteria and then used the weight coefficients of the included subjects to estimate the national level.

Every participant in the CHARLS study was ensured written informed consent, signifying their voluntary participation and acknowledgment of the research's objectives. Moreover, the initial CHARLS data collection received ethical approval from the Peking University Ethical Review Committee (IRB00001052-11015), and all CHARLS participants provided written informed consent. The current analysis was also approved by the Fenyang College, Shanxi Medical University (BB24-35012).

Hypertension

CHARLS measured seated systolic blood pressure (SBP) and diastolic blood pressure (DBP) for each participant using an automated blood pressure detector (Omron ™HEM-7200 Monitor, made by Omron (Dalian) Co., LTD., Dalian, China). The average of the three available blood pressure measurements was used in our analysis. Measurements were performed by trained personnel according to standardized CHARLS procedures. CHARLS also determined whether a participant had hypertension by asking the question, "Have you been diagnosed with Hypertension?" and assessed the use of hypertension treatment with the question, "Are you now taking any of the following treatments to treat or control

your hypertension? (Check all that apply) Taking Chinese traditional medicine, taking Western modern medicine?".

According to the 2018 Chinese hypertension guidelines, hypertension was defined as clinical systolic blood pressure ≥ 140 mmHg and/or systolic blood pressure ≥ 90 mmHg or self-reported hypertension or self-reported taking antihypertensive medication. The guideline also confirmed the goal of blood pressure control in patients with diabetes mellitus (< 130/80 mmHg), older people over 65 years of age (< 150/90 mmHg), and general participants (< 140/90 mmHg).

Depressive symptom

Depressive symptoms were evaluated using the 10 item Center for Epidemiological Studies Depression Scale (CES-D-10). This scale comprises four response options for each item: (1) rarely or none of the time (< 1 day); (2) some of few times (1–2 days); (3) Occasionally or moderate amount of times (3–4 days); (4) most or all of the time (5–7 days). Each option holds values ranging from 0 to 3. The cumulative score spans from 0 to 30, with lower scores indicating fewer depressive symptoms. A cut-off score of ≥ 10 was utilized to identify individuals exhibiting significant depressive symptoms [12].

Covariables

The covariates considered in this study included: age, gender (male and female), marriage status (never married, married, separated/divorced/widowed), education level (illiterate, elementary school, middle/high school, university and above), smoking status (no, yes), alcohol drinking (no, occasional drinker, regular drinker), SBP, DBP, body mass index (BMI). Diabetes was determined by a self-reported history of diabetes, current or past use of diabetes medications, fasting blood glucose levels ≥ 7.0 mmol/L, random blood glucose levels ≥ 11.1mmol/L, or hemoglobin A1c (HbA1c) levels ≥ 6.5%.

Statistical analysis

According to the 2018 Chinese hypertension guidelines, CHARLS sampling weights were used to estimate the percentage and number (95%CI) of Chinese adults with hypertension combined with depressive symptom, recommended antihypertensive treatment, and hypertension control status. Descriptive analysis was used to describe the baseline characteristics of hypertensive patients with depressive symptom. Continuous variables were expressed as mean (standard deviation) or median (interquartile range), and categorical variables were expressed as n (%). Chi-square test and ANOVA were used to compare differences between groups. The COX proportional hazard model was used to estimate the hazard ratio (HR) and 95%CI of all-cause mortality between different hypertension and depression groups. To further estimate the stability of the association between blood pressure and all-cause mortality, we performed subgroup analyses by age and sex. All reported *P*-values were two-side, and data collation and analysis were performed using Stata 16.0 and R (version 4.0.2).

Results

Characteristics of study population

There were 12,548 participants in this study, with a mean age of 59.41 ± 9.43 years, of whom 48.3% were male, the screening flow chart was shown in Fig. 1. The hypertensive population, as defined by the 2018 Chinese guidelines, was 5168, with a prevalence of 41.19%. Moreover, 4740 participants were classified as depression, and a total of 254 deaths were followed up. The BMI, SBP and DBP of hypertensive patients combined with depression was 23.65 (5.62), 148.26 (20.98) and 83.12 (12.04), respectively. In addition, these subjects were characterized as Table 1 according to different stratification conditions. The subjects were predominantly 60–74 years old, with a percentage of 46.7%. The proportion of female (62.1%) was higher than that of male (37.9%). Educational level was predominantly Elementary school, accounting for 42.7%. Smokers accounted for 26.6%, and the percentage of regular alcohol consumption was higher at 27.8% (Table 1). Table 1 demonstrated other socio-demographic characteristics of the study population.

Percentage and number of different hypertension and depressive states

CHARLS sampling weights were used to estimate the percentage and number (95%CI) of Chinese adults. we estimated that 91.10 million (95% CI: 86.28, 95.93) Chinese adults experienced depressed without hypertension, constituting 18.97% (95% CI: 17.63, 20.39) of the population. The number and percentage of individuals with hypertension but without depressive symptom were 135.71 million (95%CI: 127.05, 144.37) and 28.26% (95%CI: 26.27, 30.34), respectively. Additionally, the number and percentage of hypertensive patients combined with depressive symptom were 72.06 million (95%CI: 66.91, 77.23) and 15.01% (95%CI: 13.80, 16.31) respectively. Notably, the prevalence of hypertensive patients combined with depressive symptom was higher among older adults (≥ 65 years) and women, with rates of 23.35% and 17.73%, respectively (Table 2).

Among hypertensive patients combined with depressive symptom who were not taking antihypertensive medication, approximately 28.49 million (95% CI: 27.07, 29.92) participants were advised to start antihypertensive medication, while 8.23 million (95% CI: 6.81, 9.66) participants were not advised to start antihypertensive medication. In contrast, among hypertensive patients combined with depressive symptom who were

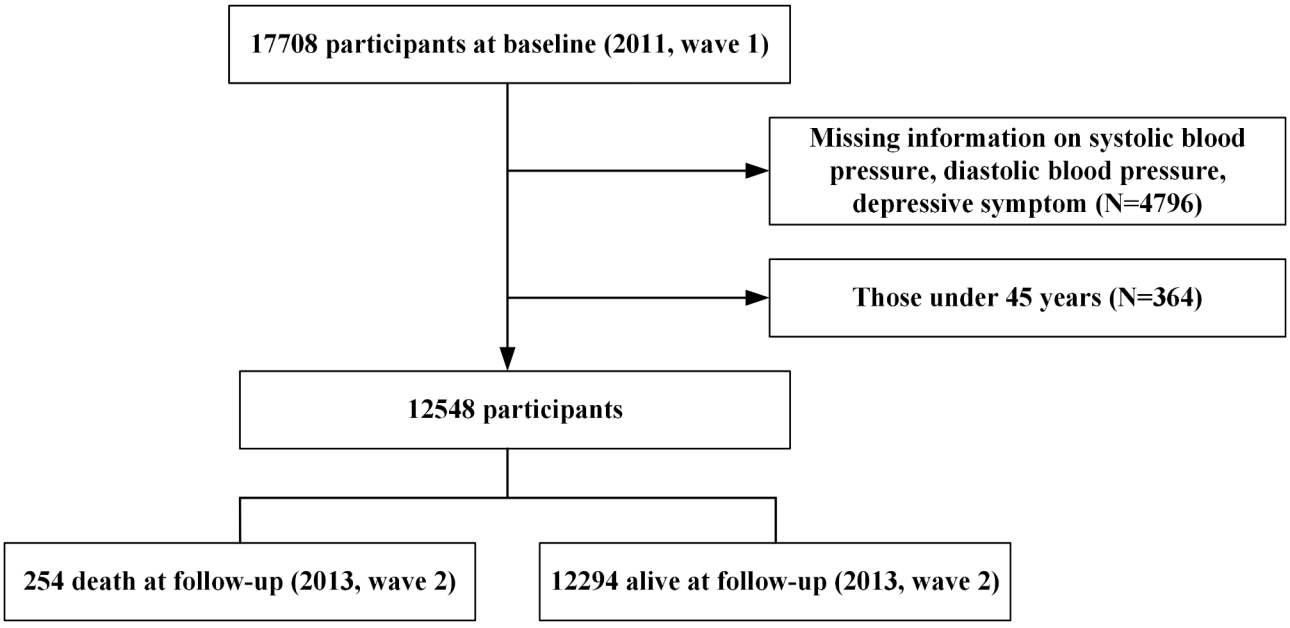

Fig. 1 Screening flow chart

taking antihypertensive medication, 19.53 million (95% CI: 18.01, 21.06) participants had blood pressure above the target, and 15.81 million (95% CI: 14.28, 17.33) participants had blood pressure below the target (Table 3).

Association between hypertension and depression combination categories and mortality

In exploring the association between different categories of hypertension and depression combinations and all-cause mortality, we observed a significantly lower cumulative survival in individuals with hypertension but not depression, depression but not hypertension, and both hypertension and depression, compared to those with normal blood pressure and no depression (Fig. 2) (Log-rank test $P<0.05$). After adjusted the covariables, the HR of all-cause mortality in the Cox model confirmed these observations. Hypertension but not depression (HR = 2.07, 95% CI: 1.41, 3.02), depression but not hypertension (HR = 1.96, 95% CI: 1.30, 2.95), and hypertension and depression (HR = 2.21, 95% CI: 1.48, 3.31) increased the risk of all-cause mortality compared to individuals with normal blood pressure and no depression (P for proportional-hazards assumption = 0.271)(Table 4). Subgroup analyses by gender and age showed similar results.

Discussion

Our study aimed to elucidate the size and characteristics of the Chinese population affected by both hypertension and depressive symptom, and to investigate the association between this combination and all-cause mortality. We discovered that 15.01% of Chinese adults were concurrently dealing with hypertension and depressive symptom. Among those not taking antihypertensive medication, approximately 28.49 million (95% CI: 27.07, 29.92) were recommended to initiate such medication. Conversely, among those already on antihypertensive medications, 19.53 million (95% CI: 18.01, 21.06) did not achieve the control goal. Furthermore, our study identified a significant increase in all-cause mortality among individuals with both hypertension and depressive symptom.

A notable proportion of hypertensive patients with depressive symptom were identified (18.97%, 95% CI: 17.63, 20.39). High prevalence, coupled with low treatment and control rates, had long been a serious challenge in hypertension prevention and control. According to the latest data, China's hypertension treatment and control rates stood at 45.8% and 16.8% [10], respectively. In our study, approximately 28.49 million individuals (95% CI: 28.34, 30.97) were recommended to initiate antihypertensive medication but had not done so, constituting approximately three-quarters of the population. This suggested significant room for improvement in preventing and controlling hypertension, with this proportion exceeding the control rate of hypertension alone (45.8%). It indicates that depression may indeed influence hypertension treatment. Regarding control rates, our study revealed that only about 55.28% of cases achieved satisfactory control levels, significantly lower than the North American rate of 39.64% [22]. Research indicated that effective blood pressure management varied widely globally, particularly in low- and middle-income countries, where rates were notably low [23]. Furthermore, our study found that the combination of hypertension and

Table 1 Baseline characteristics of Chinese adults with hypertension, depression or both

	Total	Normal blood pressure and not depression	Hypertension but not depression	Depression but not hypertension	Hypertension and depression
N	12,548	4648	3160	2732	2008
Age	59.41 (9.43)	57.01 (8.66)	61.43 (9.57)	58.56 (9.04)	62.96 (9.66)*
Age group					
45–59	7124 (56.8%)	3154 (67.9%)	1511 (47.8%)	1656 (60.6%)	803 (40.0%)*
60–74	4519 (36.0%)	1298 (27.9%)	1348 (42.7%)	935 (34.2%)	938 (46.7%)
≥ 75	905 (7.2%)	196 (4.2%)	301 (9.5%)	141 (5.2%)	267 (13.3%)
Gender					
Male	6056 (48.3%)	2550 (54.9%)	1638 (51.8%)	1107 (40.5%)	761 (37.9%)*
Female	6492 (51.7%)	2098 (45.1%)	1522 (48.2%)	1625 (59.5%)	1247 (62.1%)
Marriage status					
Never married	95 (0.8%)	28 (0.6%)	17 (0.5%)	23 (0.8%)	27 (1.3%)*
Married	10,958 (87.3%)	4295 (92.4%)	2746 (86.9%)	2364 (86.5%)	1553 (77.3%)
Separated/ divorced/ widowed	1495 (11.9%)	325 (7.0%)	397 (12.6%)	345 (12.6%)	428 (21.3%)
Education					
Illiterate	3426 (27.3%)	980 (21.1%)	805 (25.5%)	866 (31.7%)	775 (38.6%)*
Elementary school	5128 (40.9%)	1804 (38.8%)	1248 (39.5%)	1218 (44.6%)	858 (42.7%)
Middle/high school	3763 (30.0%)	1754 (37.7%)	1018 (32.2%)	630 (23.1%)	361 (18.0%)
University and above	231 (1.8%)	110 (2.4%)	89 (2.8%)	18 (0.7%)	14 (0.7%)
Smoking status					
No	8626 (68.7%)	3013 (64.8%)	2195 (69.5%)	1944 (71.2%)	1474 (73.4%)*
Yes	3922 (31.3%)	1635 (35.2%)	965 (30.5%)	788 (28.8%)	534 (26.6%)
Alcohol drinking					
No	7377 (58.8%)	2608 (56.1%)	1780 (56.3%)	1733 (63.4%)	1256 (62.5%)*
Occasional drinker	1273 (10.1%)	514 (11.1%)	292 (9.2%)	274 (10.0%)	193 (9.6%)
Regular drinker	3898 (31.1%)	1526 (32.8%)	1088 (34.4%)	725 (26.5%)	559 (27.8%)
SBP	130.89 (21.59)	119.00 (11.52)	148.70 (19.87)	117.74 (11.54)	148.26 (20.98)*
DBP	76.12 (12.19)	71.24 (8.81)	84.29 (12.21)	69.81 (8.87)	83.12 (12.04)*
BMI	23.13 (4.97)	22.78 (4.41)	24.42 (5.31)	22.12 (4.43)	23.65 (5.62)*

*$P < 0.05$

Table 2 Percentage and number of Chinese adults with hypertension, depression, or both

	Hypertension but not depression		Depression but not hypertension		Hypertension and depression	
	Percentage	Number, millions	Percentage	Number, millions	Percentage	Number, millions
Total	28.26 (26.27, 30.34)	135.71 (127.05, 144.37)	18.97 (17.63, 20.39)	91.10 (86.28, 95.93)	15.01 (13.80, 16.31)	72.06 (66.91, 77.23)
< 65	25.51 (23.41, 27.73)	90.20 (82.27, 98.13)	20.07 (18.52, 21.71)	70.98 (66.71, 75.24)	12.02 (10.75, 13.42)	42.52 (38.12, 46.91)
≥ 65	35.96 (32.71, 39.35)	45.51 (41.85, 49.17)	15.91 (14.00, 18.01)	20.13 (17.80, 22.46)	23.35 (21.08, 25.80)	29.55 (26.87, 32.23)
Male	29.03 (26.72, 31.44)	67.98 (62.78, 73.18)	15.99 (14.65, 17.42)	37.44 (34.34, 40.54)	12.15 (10.83, 13.61)	28.46 (25.62, 31.29)
Female	27.54 (24.77, 30.49)	67.7 (60.78, 74.67)	21.82 (20.03, 23.72)	53.66 (49.88, 57.45)	17.73 (16.01, 19.59)	43.61 (39.31, 47.91)

The data in bracket were 95% confidence intervals

depression significantly elevates patient mortality rates. Therefore, the higher prevalence and lower control levels observed may impose a substantial burden on cardiovascular disease prevention and treatment in China in the future.

This study found that hypertension combined with depressive symptom was associated with an increased risk of all-cause mortality. Globally, hypertension was a significant cause of premature death, with an estimated 8.5 million deaths worldwide in 2015 due to systolic blood pressure > 115 mmHg, 88% of these occurred in low- and middle-income countries [2, 24, 25]. Previous studies had consistently demonstrated the association between depression and mortality risk [26, 27]. The 2016 Global Burden of Disease Study reported more than 34 million disability-adjusted life years associated with depression [18]. Mortality resulting from the combination of depression and hypertension may be attributed

Table 3 Number of Chinese adults with hypertension and depression, recommended initiating antihypertensive medication, above goal blood pressure

		Number	95%CI
Recommended antihypertensive medication initiation for the participants of hypertension and depression (among those not taking medication)	Recommended	28.49	(27.07, 29.92)
	Not recommended	8.23	(6.81, 9.66)
Above goal BP for the participants of hypertension and depression (among those taking medication)	Above goal BP	19.53	(18.01, 21.06)
	Blew goal BP	15.81	(14.28, 17.33)

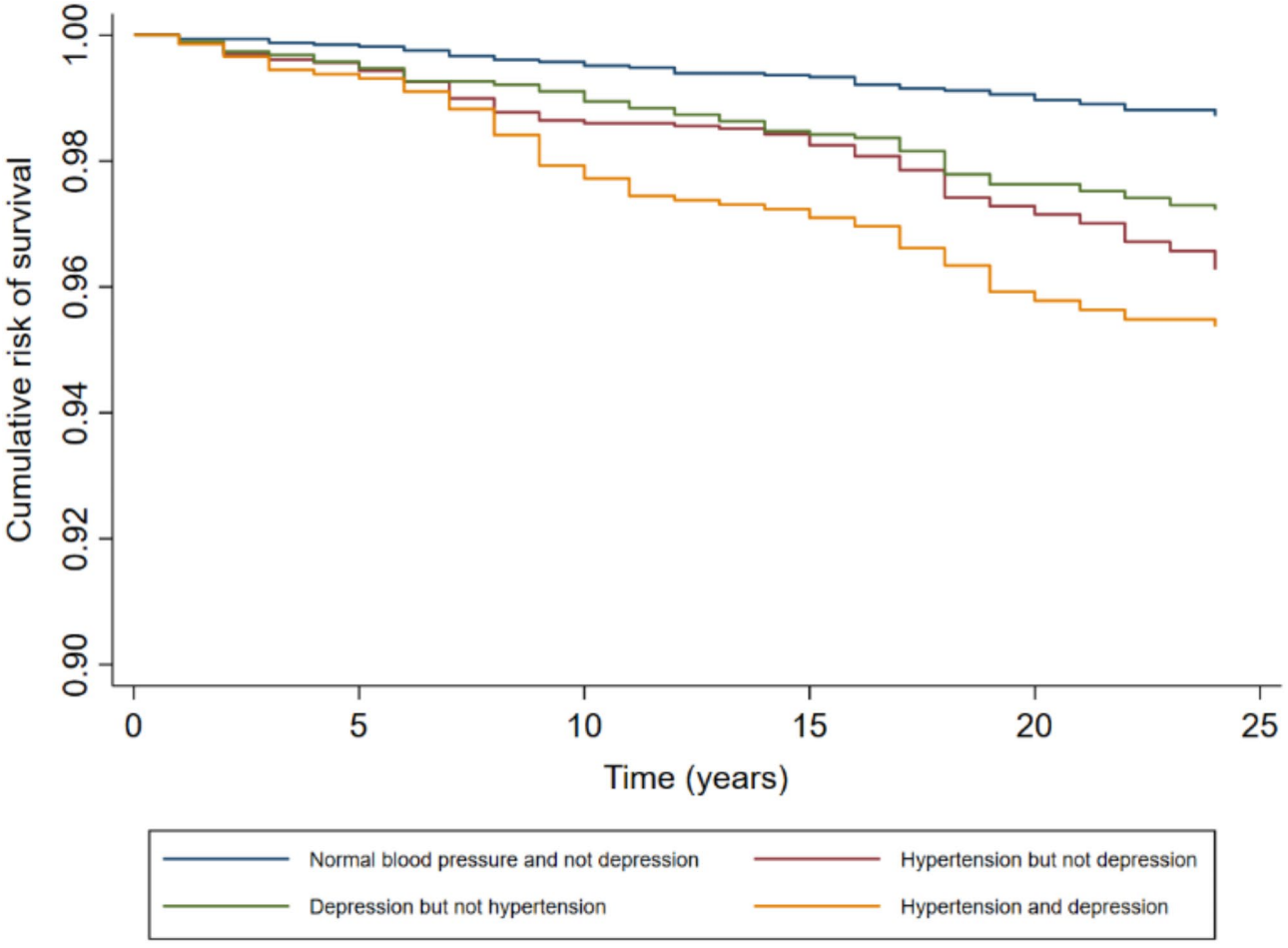

Fig. 2 Cumulative incidence of survival according to hypertension and depression combination categories

to depression itself. Some studies had identified that depression activates multiple pathophysiological mechanisms [28, 29], potentially contributing to disease onset and reducing survival. In addition, stress factors, such as depression, could activate the sympathetic nerve thereby, leading to increased blood pressure [30]. Furthermore, depression could impact medication adherence in hypertensive patients, worsening the condition and diminishing survival rates. Clinical trials had indicated that the combination of antidepressants and antihypertensive drugs was more effective in lowering blood pressure [17]. Our findings aligned with these conclusions, highlighting that hypertension combined with depression carries a higher risk of death compared to hypertension alone or depression alone. Given the rising prevalence of depression in China [31] and the aging population trend, the co-occurrence of depression and hypertension posed a substantial threat to the health of China's future middle-aged and elderly population. Therefore, it was recommended to upgrade the relevant healthcare system to effectively address the potential public health

Table 4 Hazard ratios of all-cause mortality according to hypertension and depression combination categories

	HR	95%CI
Total		
Normal blood pressure and not depression	Ref.	
Hypertension but not depression	2.07	1.41, 3.02
Depression but not hypertension	1.96	1.30, 2.95
Hypertension and depression	2.21	1.48, 3.31
Ade < 65		
Normal blood pressure and not depression	Ref.	
Hypertension but not depression	2.61	1.40, 4.87
Depression but not hypertension	2.68	1.43, 5.04
Hypertension and depression	2.55	1.24, 5.25
Age ≥ 65		
Normal blood pressure and not depression	Ref.	
Hypertension but not depression	1.83	1.14, 2.94
Depression but not hypertension	1.52	0.89, 2.60
Hypertension and depression	2.10	1.29, 3.42
Male		
Normal blood pressure and not depression	Ref.	
Hypertension but not depression	1.75	1.10, 2.80
Depression but not hypertension	1.91	1.15, 3.18
Hypertension and depression	2.61	1.59, 4.28
Female		
Normal blood pressure and not depression	Ref.	
Hypertension but not depression	2.58	1.30, 5.11
Depression but not hypertension	2.22	1.09, 4.55
Hypertension and depression	1.93	0.96, 3.91

The age, gender, marriage status, education, smoking status, alcohol drinking and BMI were adjusted except for the grouping variable

pressure resulting from elevated cases of hypertension and depression.

This study utilized nationally representative data to explore the population size of hypertension and depressive symptom and their association with all-cause mortality, providing a more representative and generalizable perspective. This addresses a gap in our understanding of mortality risk associated with the combination of hypertension and depression, offering a foundation for the development of public health policies. Nevertheless, several limitations should be acknowledged. Firstly, the baseline survey information relied on participant recall, introducing the possibility of recall bias. Secondly, as the study focused on participants aged 45 and above, the findings may not be applicable to those under 45. Thirdly, the use of data from 2011 to 2012 may result in underestimation of current prevalence characteristics. Fourthly, this study deleted some subjects, which may cause bias in estimating the national level. Fifthly, this study used CES-D to determine whether the subjects had depression. Because CES-D is mainly used for screening, it is mainly judged by whether the study subjects have depressive symptoms, which greatly overestimates the size of the depressed population. Finally, certain factors such as diet, which could influence the association between hypertension combined with depression and mortality, were not available in this study.

Conclusion

In summary, our results indicated a substantial number of hypertensive patients in China were also affected by depressive symptom, with low treatment and control rates. The combination of high blood pressure and depressive symptom was associated with a higher risk of all-cause mortality. Strategies for hypertension prevention and treatment should be integrated with considerations for depression.

Abbreviations

CHARLS	China health and retirement longitudinal study
SBP	Systolic blood pressure
DBP	Diastolic blood pressure
CES-D-10	10 item center for epidemiological studies depression scale
BMI	Body mass index
HR	Hazard ratio

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Author contributions

S.L. did the analysis and drafted the initial manuscript. H.W. and Y.G. critically reviewed and revised the manuscript. S.L. and T.X. critically reviewed the results of analyses, and reviewed and revised the manuscript. All authors were responsible for the study concept and design and approved the final draft of the manuscript.

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Data availability

The datasets utilized in this study are accessible through the China Health and Retirement Longitudinal Study (CHARLS) database (https://charls.charlsdata.com/pages/data/111/en.html).

Declarations

Ethical approval and consent to participate

All procedures conducted in studies involving human participants adhered to the principles of the Declaration of Helsinki. The original CHARLS study received approval from the Ethical Review Committee of Peking University, and all participants provided signed informed consent before their involvement in CHARLS.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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