


BMJ Open Hypertension, socioeconomic status and depressive and anxiety disorders: a cross-sectional study of middle-aged and older Chinese women

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ABSTRACT

Objectives To investigate the association of hypertension with depressive and anxiety disorders in middle-aged and older Chinese women, and to further assess whether the association was influenced by socioeconomic status (SES).

Design Nationwide cross-sectional study.

Setting Six provinces of the eastern, central and western regions of China.

Participants Women aged 40–70 years were included by a multistage stratified random cluster sampling in 2018 (N=9900).

Primary outcome measures Depressive and anxiety disorders were measured by the Patient Health Questionnaire-9 and the Generalized Anxiety Disorder-7, respectively. Logistic regression models were used to evaluate the OR and 95% CI for hypertension and the odds of depressive and anxiety disorders.

Results 18.5% of participants reported having hypertension; 20.9% and 15.3% of women experienced depressive and anxiety disorders, respectively. After adjusting for potential confounders, women diagnosed with hypertension were more likely to have depressive (OR=1.27, 95% CI 1.11 to 1.45) and anxiety disorders (OR=1.48, 95% CI 1.28 to 1.71) than those without hypertension. Stratified analyses demonstrated that hypertension was significantly associated with higher odds of depressive disorders in women living in rural areas (OR=1.34, 95% CI 1.13 to 1.59), with lower levels of education (OR=1.28, 95% CI 1.12 to 1.46) and with average monthly household income <¥3000 (OR=1.33, 95% CI 1.12 to 1.59), while hypertension was significantly correlated with increased odds of anxiety disorders in women living in urban (OR=1.41, 95% CI 1.12 to 1.79) and rural areas (OR=1.53, 95% CI 1.27 to 1.84), with lower levels of education (OR=1.47, 95% CI 1.27 to 1.70), and with average monthly household income <¥3000 (OR=1.45, 95% CI 1.20 to 1.75) and ≥¥3000 (OR=1.49, 95% CI 1.18 to 1.86).

Conclusions Hypertension was associated with increased odds of depressive and anxiety disorders among middle-aged and older women, especially in those with low SES. Effective strategies and actions for identification and management of hypertension and depressive and anxiety disorders are needed.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This is one of the largest cross-sectional studies of middle-aged and older women (N=9900) from six provinces in China.
- ⇒ This study examined the association between hypertension and the odds of depressive and anxiety disorders while adjusting for potential important confounders.
- ⇒ The study also evaluated the impact of socioeconomic status on the relationship between hypertension and the odds of depressive and anxiety disorders.
- ⇒ Depressive (Patient Health Questionnaire-9) and anxiety (Generalized Anxiety Disorder-7) disorders were measured by validated instruments.
- ⇒ Due to the nature of a cross-sectional design, this study cannot evaluate the causality between hypertension and the odds of depressive and anxiety disorders.

INTRODUCTION

Depression and anxiety have become major mental health concerns in low-income, middle-income and high-income countries, and their lifetime risk has been increasing steadily over the past few decades.^{1 2} Depression has been projected to be the first cause of burden of disease by 2030 globally and has become a leading cause of suicides in China.¹ Previous evidence indicated that women were more likely to have higher incidence of depression and anxiety than men, and that there was a modest peak in prevalence in the fifth and sixth decades of life in both genders.^{1 3–5} It has been estimated that 26.0% and 12.6% of Chinese women aged 40–60 years suffer from depressive and anxiety disorders, respectively.⁶ Depression and anxiety are associated with functional impairment, reduced quality of life, and increased likelihood of cardiovascular risk factors and mortality. With the increase in ageing population and social transitions, China is set to

experience more severe health burden caused by depression and anxiety, particularly among middle-aged and older Chinese women.

Hypertension has been considered a main risk factor for cardiovascular disease and premature deaths globally, and its prevalence has been increasing over the past decades.⁷ In 2018, the National Chronic Disease and Risk Factor Surveillance conducted in 298 counties/districts in China reported that the prevalence of hypertension in Chinese adults was 27.5%, 30.8% in men and 24.2% in women.⁸ A body of evidence indicated a link between hypertension and depressive and anxiety disorders. A previous meta-analysis including six studies reported a positive association between depression and hypertension in elderly populations.⁹ Previous studies also reported that individuals with hypertension were more likely to experience depressive disorders,^{10 11} while depressive disorders were correlated with increased odds of hypertension in middle-aged and older adults.^{12 13}

Different socioeconomic status (SES) leads to different degrees of social, cultural, political and economic conditions among populations, which may then affect health outcomes. Education and income are widely used as generic indicators of SES in epidemiological studies, since education is considered to reflect the knowledge-related assets of individuals, while income is thought to estimate material resources and affordable healthcare.¹⁴ Urban–rural residency is another important indicator of SES in China, as rural and urban areas have considerable disparity in lifestyle, environment, occupation and social structure, economic level, and healthcare delivery.^{15 16} Previous evidence showed that low SES was associated with higher prevalence of depression and anxiety and worse prognosis outcomes.^{17–19} Further, a previous meta-analysis suggested that low SES was linked with hypertension, and this relationship was especially evident in different levels of education.²⁰ However, little is known whether the relationship between hypertension and the risk of depressive and anxiety disorders may be affected by SES.

This study, therefore, aimed to investigate the association of hypertension with depressive and anxiety disorders in middle-aged and older Chinese women, and to further assess whether the association was influenced by SES.

METHODS

Study design and participants

This cross-sectional, community-based study of women was carried out in six provinces of three socioeconomic regions of China: western (Sichuan and Shanxi provinces), central (Anhui and Hunan provinces) and eastern (Shandong and Jiangsu provinces). The capital of each province was treated as the representative city, and one urban area and one rural area were selected randomly as survey sites in each city. Women aged 10–70 years were recruited by a multistage stratified random cluster sampling in all the survey sites.²¹ Specifically, townships/

streets in each survey site were sorted according to the distance from the county/district government location and were equally divided into two layers. One township/street was randomly selected from each layer as a sample township/street. In the second stage, in each sample township/street mentioned above, villages/neighbourhood committees were sorted according to the distance from the road where the town government/street office is located and were equally divided into two layers. One village/neighbourhood committee was randomly selected from each layer. In the third stage, all women who met the inclusion criteria were recruited from the survey villages/neighbourhood committees. Face-to-face interviews were conducted by well-trained health service workers to collect information on demographic characteristics, medical history, lifestyle factors, and depressive and anxiety disorders. We assumed that the prevalence of depression or anxiety was 5% in women aged 40–70 years. According to the formula used to calculate the sample size for cross-sectional studies (number of participants=400×[1–prevalence of a disease]/prevalence of a disease), 7600 women were required. Finally, a total of 12 000 women aged 40–70 years were invited to participate in this survey. We received questionnaires from 10 103 women (participation rate 84.2%).

Of the 10 103 women, 9900 were included in the current analysis. Participants meeting the following criteria were excluded: incomplete data on hypertension (n=45) or depressive disorders (n=141) or anxiety disorders (n=116). All participants provided written informed consent.

Assessment of hypertension

Hypertension was defined as participants' self-report of having been diagnosed with hypertension by a doctor and/or currently taking antihypertensive medications.

Assessment of depressive and anxiety disorders

The Chinese version of the Patient Health Questionnaire-9 (PHQ-9) was used to assess depressive disorders,²² which has been proven to have adequate validity and reliability.²³ Participants were required to rate each of the nine disorders from 0 (not at all) to 3 (nearly every day) within the past 14 days, with a total score of 0–27. Based on the sum of the PHQ-9 scores, participants were classified as having depressive disorders (PHQ-9 score ≥5) or no depressive disorders (PHQ-9 score <5).²⁴ The Cronbach's α of the PHQ-9 in this study was 0.86.

Anxiety disorders were examined using the Chinese version of the Generalized Anxiety Disorder-7 (GAD-7), consisting of seven questions, during the last 14 days, with a total score of 0–21.²⁵ Participants were classified as having anxiety disorders (GAD-7 score ≥5) or no anxiety disorders (GAD-7 score <5) according to the sum of the GAD-7 scores.²⁶ The Cronbach's α of the GAD-7 in this study was 0.87.

Assessment of covariates

Covariates for this study included age (continuous), place of residence (urban or rural), education (high school and below, college or graduate school), employment status (employed, unemployed or retired), marital status (married, single/divorced/widowed), average monthly household income ($<¥3000$ or $\geq¥3000$), drinking (yes or no), smoking (not current smoker, current smoker), physical activity (yes or no), body mass index (BMI; <18.5 , $18.5\text{--}23.9$, $24\text{--}27.9$, ≥ 28 kg/m²), diabetes (yes or no) and dyslipidaemia (yes or no). BMI was calculated as the weight in kilograms divided by the square of height in metres, and classified into four groups according to Chinese standards: underweight (BMI <18.5 kg/m²), normal weight (18.5 kg/m² \leq BMI <24 kg/m²), overweight (24 kg/m² \leq BMI <28 kg/m²) and obese (BMI ≥ 28 kg/m²).²⁷ Data on diabetes and dyslipidaemia was obtained according to previous diagnosis reported by the participants.

Statistical analysis

Characteristics were presented as numbers and percentages for categorical variables, and χ^2 tests were conducted for comparison between participants with hypertension and without hypertension. Non-normally distributed variables were described as median and IQR, and were examined between the hypertension and non-hypertension groups using Mann-Whitney U test. First, univariate logistic regression models were performed to calculate the OR and the 95% CI of hypertension and the odds of anxiety and depressive disorders. In addition, multi-variable logistic regression models were conducted to estimate the association of hypertension with the odds of anxiety and depressive disorders, adjusting for age, place of residence, education, employment status, marital status, average monthly household income, drinking, smoking, physical activity, BMI, diabetes and dyslipidaemia. Stratified analyses were carried out according to place of residence (urban or rural), education (high school and below, college or graduate school) and average monthly household income ($<¥3000$ or $\geq¥3000$). Analyses were conducted in SAS V.9.4 software. P values are two-sided, with $p<0.05$ regarded as statistically significant.

Patient and public involvement

Patients and/or the public were not involved in the design, or conduct, or reporting or dissemination plans of this research.

RESULTS

Characteristics of study participants

Of 9900 women, 18.5% (1830) reported having hypertension, while 20.9% (2074) and 15.3% (1512) experienced depressive and anxiety disorders, respectively. The prevalence of depressive disorders was 28.5% (522/1830) and 19.2% (1552/8070) in women diagnosed with hypertension and without hypertension (figure 1A). In addition, 21.6% (395/1830) and 13.8% (1117/8070) of

women who reported hypertension and those who did not report hypertension experienced anxiety disorders (figure 1B). Table 1 shows the characteristics of the study participants according to hypertension. Women with hypertension were more likely to be older and reside in rural areas, have lower levels of education and average monthly household income, have higher odds of obesity, diabetes and dyslipidaemia (all $p<0.05$), and less likely to be employed and married (both $p<0.001$).

Association of hypertension with depressive and anxiety disorders

Table 2 illustrates the association of hypertension with the odds of depressive and anxiety disorders. In the unadjusted model, women diagnosed with hypertension were more likely to have depressive disorders than those without hypertension (OR=1.68, 95% CI 1.49 to 1.88). After adjusting for age, place of residence, education, employment status, marital status, average monthly household income, drinking, smoking, physical activity, BMI, diabetes and dyslipidaemia, the association of hypertension with the odds of depressive disorders remained significant (OR=1.27, 95% CI 1.11 to 1.45).

In the unadjusted model, women diagnosed with hypertension were more likely to have anxiety disorders compared with their peers without hypertension (OR=1.71, 95% CI 1.51 to 1.95). After multiple adjustment, women with hypertension had 1.48-fold elevated odds of anxiety disorders than those without hypertension (OR=1.48, 95% CI 1.28 to 1.71).

Association of hypertension with depressive and anxiety disorders by SES

Online supplemental table 1 exhibits the SES of the study participants according to depressive and anxiety disorders. Women living in rural areas and having lower levels of average monthly household income were more likely to experience depressive and anxiety disorders (all $p<0.001$). Stratified analyses were subsequently performed to evaluate the associations of hypertension with depressive and anxiety disorders by place of residence (urban or rural; table 3), education (high school and below, college or graduate school; table 3) and average monthly household income ($<¥3000$ or $\geq¥3000$; table 3). After adjusting for potential confounders, hypertension was significantly associated with increased odds of depressive disorders in women living in rural areas (OR=1.34, 95% CI 1.13 to 1.59), with lower levels of education (OR=1.28, 95% CI 1.12 to 1.46) and with average monthly household income $<¥3000$ (OR=1.33, 95% CI 1.12 to 1.59), while the associations were not statistically significant in women living in urban areas (OR=1.18, 95% CI 0.96 to 1.45), with higher levels of education (OR=0.96, 95% CI 0.47 to 1.98) and with average monthly household income $\geq¥3000$ (OR=1.16, 95% CI 0.94 to 1.42).

Moreover, after multiple adjustments, hypertension was significantly correlated with higher odds of anxiety disorders in women living in urban (OR=1.41, 95% CI 1.12 to

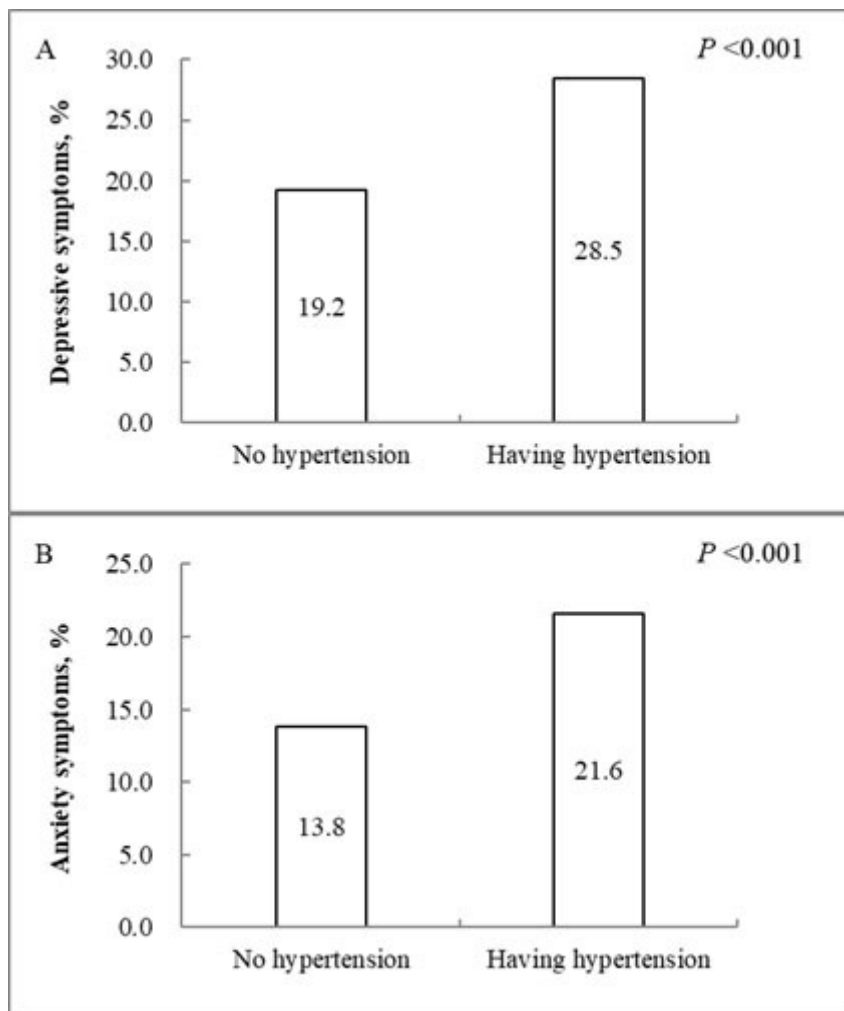


Figure 1 Percentage of depressive (A) and anxiety disorders (B) by hypertension.

1.79) and rural areas (OR=1.53, 95% CI 1.27 to 1.84), with lower levels of education (OR=1.47, 95% CI 1.27 to 1.70), and with average monthly household income <¥3000 (OR=1.45, 95% CI 1.20 to 1.75) and ≥¥3000 (OR=1.49, 95% CI 1.18 to 1.86), whereas the association was not statistically significant in women with higher levels of education (OR=1.70, 95% CI 0.80 to 3.61).

We also reported the association of hypertension with depressive and anxiety disorders by place of residence, education and average monthly household income in the eastern (online supplemental table 2), central (online supplemental table 3) and western (online supplemental table 4) regions of China, respectively. In eastern China, hypertension was significantly associated with increased odds of anxiety disorders in women living in rural areas (OR=1.87, 95% CI 1.24 to 2.84), with lower levels of education (OR=1.62, 95% CI 1.19 to 2.21) and with average monthly household income ≥¥3000 (OR=1.70, 95% CI 1.14 to 2.54). In central China, hypertension was significantly associated with increased odds of depressive disorders in women living in rural areas (OR=1.38, 95% CI 1.09 to 1.74). In western China, hypertension was significantly associated with increased odds of depressive disorders in women living in rural areas (OR=1.42, 95% CI 1.08 to

1.86), with lower levels of education (OR=1.29, 95% CI 1.04 to 1.60) and with average monthly household income <¥3000 (OR=1.38, 95% CI 1.08 to 1.76), whereas hypertension was significantly associated with increased odds of anxiety disorders in women living in urban (OR=1.83, 95% CI 1.29 to 2.61) and rural areas (OR=1.61, 95% CI 1.22 to 2.14), with lower levels of education (OR=1.67, 95% CI 1.33 to 2.09), and with average monthly household income <¥3000 (OR=1.55, 95% CI 1.20 to 2.01) and ≥¥3000 (OR=1.96, 95% CI 1.29 to 2.97).

DISCUSSION

In this cross-sectional study of 9900 Chinese women aged 40–70 years, we found that women diagnosed with hypertension were more likely to experience depressive and anxiety disorders than those who did not have hypertension. Furthermore, the positive association between hypertension and depressive disorders was observed in women residing in rural areas and in those with lower levels of education and average monthly household income, while hypertension was associated with higher odds of anxiety disorders in women with lower levels of education.

Table 1 Characteristics of participants by hypertension

	Total (N=9900)	Hypertension		P value
		No (n=8070)	Yes (n=1830)	
Depressive disorders				<0.001
No	7826 (79.1)	6518 (80.8)	1308 (71.5)	
Yes	2074 (20.9)	1552 (19.2)	522 (28.5)	
Anxiety disorders				<0.001
No	8388 (84.7)	6953 (86.2)	1435 (78.4)	
Yes	1512 (15.3)	1117 (13.8)	395 (21.6)	
Sociodemographic characteristics				
Age, years, median (IQR)	49 (45–59)	48 (44–56)	56 (49–64)	<0.001
Place of residence				<0.001
Urban	4945 (49.9)	4108 (50.9)	837 (45.7)	
Rural	4955 (50.1)	3962 (49.1)	993 (54.3)	
Education				<0.001
High school and below	9128 (92.2)	7362 (91.2)	1766 (96.5)	
College or graduate school	772 (7.8)	708 (8.8)	64 (3.5)	
Employment status				<0.001
Employed	7746 (78.2)	6415 (79.5)	1331 (72.7)	
Unemployed/retired	2154 (21.8)	1655 (20.5)	499 (27.3)	
Marital status				<0.001
Married	8786 (88.8)	7248 (89.8)	1538 (84.0)	
Single/divorced/widowed	1114 (11.2)	822 (10.2)	292 (16.0)	
Average monthly household income, ¥				<0.001
<3000	4118 (41.6)	3125 (38.7)	993 (54.3)	
≥3000	5782 (58.4)	4945 (61.3)	837 (45.7)	
Lifestyle factors				
Drinking				0.923
No	8790 (88.8)	7164 (88.8)	1626 (88.9)	
Yes	1110 (11.2)	906 (11.2)	204 (11.1)	
Smoking				0.123
Not current smoker	9638 (97.4)	7866 (97.5)	1772 (96.8)	
Current smoker	262 (2.6)	204 (2.5)	58 (3.2)	
Physical activity				0.400
No	5211 (52.6)	4264 (52.8)	947 (51.8)	
Yes	4689 (47.4)	3806 (47.2)	883 (48.2)	
Physical health factors				
Body mass index, kg/m ²				<0.001
<18.5	1164 (11.8)	871 (10.8)	293 (16.0)	
18.5–23.9	5011 (50.6)	4327 (53.6)	684 (37.4)	
24–27.9	2773 (28.0)	2190 (27.1)	583 (31.9)	
≥28	952 (9.6)	682 (8.5)	270 (14.7)	
Diabetes				<0.001
No	8944 (90.3)	7656 (94.9)	1288 (70.4)	
Yes	956 (9.7)	414 (5.1)	542 (29.6)	
Dyslipidaemia				<0.001
No	8899 (89.9)	7625 (94.5)	1274 (69.6)	
Yes	1001 (10.1)	445 (5.5)	556 (30.4)	

Continued

**Table 1** Continued

	Total (N=9900)	Hypertension		P value
		No (n=8070)	Yes (n=1830)	
Values are n (%) or median (interquartile). IQR, interquartile range.				

One of the principal findings based on 9900 middle-aged and older Chinese women is that hypertension was associated with increased odds of depressive and anxiety disorders. Consistent with our findings, a previous meta-analysis including 3578 and 5833 individuals with and without hypertension from six studies reported a significant association between hypertension and depression in elderly populations.⁹ Another systematic review and meta-analysis summarising more than four million participants from 59 studies also indicated a significant association between hypertension and anxiety in both cross-sectional and prospective studies.²⁸ Additionally, a recent survey of the China Health and Retirement Longitudinal Study based on 6273 adults also reported that individuals with hypertension had 1.12-fold increased odds of depressive disorders compared with peers without hypertension.¹⁶ The potential pathophysiological mechanism underlying the link between hypertension and the odds of depressive and anxiety disorders might be partly because microvascular lesions on the prefrontal and subcortical regions could lead to vascular depression and anxiety.²⁹ Moreover, recent evidence suggested that hypertension and depressive and anxiety disorders shared candidate genes that might result in oxidative stress, low-grade inflammation and hypothalamic–pituitary–adrenal axis dysregulation.³⁰

In addition, we also found that the impact of hypertension on depressive disorders was only observed in women residing in rural areas and with lower levels of education and household income. In line with our findings, a recent study based on adults aged 45 and older also reported that the association of diagnosed hypertension with an increased risk of depression only occurred in individuals with rural residency and with lower levels of education and household income.¹⁶ Moreover, previous

studies exhibited that poor SES was not only associated with higher prevalence of hypertension, but also with higher risk of mental problems such as depression and anxiety.^{17–20} Our results also supported these points by demonstrating that women living in rural areas and having lower levels of education and household income were more likely to have hypertension and depressive and anxiety disorders. The possible explanations underlying the influence of SES on the relationship between hypertension and mental problems might be as follows. First of all, people with different SES may be exposed to diverse social environment. For example, individuals with lower levels of household income are more likely to experience higher levels of psychological stress and less likely to have access to advanced medical resources, which might lead to increased risk of mental disorders.³¹ In addition, individuals with different SES may have different lifestyles and behaviours. People living in urban areas and having higher levels of education and household income may acquire more health knowledge and have healthier lifestyles, including a well-balanced diet and regular physical activity, which might help prevent or manage physical and mental diseases such as hypertension, depression and anxiety.¹⁶

Our findings may have some public health implications as they indicate that hypertension was associated with increased odds of depressive and anxiety disorders, highlighting the importance of detection and management of hypertension and mental health. In addition, this study also emphasised the significance of socioeconomic inequality in mental health disparities by demonstrating that women with hypertension were more likely to have depressive disorders but only in those with lower SES. The WHO also recommends monitoring and evaluating

Table 2 OR (95% CI) for depressive and anxiety disorders according to hypertension status

	Unadjusted model		Adjusted model	
	OR (95% CI)	P value	OR (95% CI)	P value
Depressive disorders				
No hypertension	Ref		Ref	
Hypertension	1.68 (1.49, 1.88)	<0.001	1.27 (1.11, 1.45)	<0.001
Anxiety disorders				
No hypertension	Ref		Ref	
Hypertension	1.71 (1.51, 1.95)	<0.001	1.48 (1.28, 1.71)	<0.001
Adjusted model was adjusted for age, place of residence, education, employment status, marital status, average monthly household income, drinking, smoking, regular physical activity, body mass index, diabetes mellitus and dyslipidaemia. Ref, reference.				

Table 3 OR (95% CI) for depressive and anxiety disorders according to hypertension status in participants with hypertension compared with peers without hypertension

	Unadjusted model		Adjusted model	
	OR (95% CI)	P value	OR (95% CI)	P value
Depressive disorders				
Place of residence				
Urban	1.52 (1.28, 1.82)	<0.001	1.18 (0.96, 1.45)*	0.114
Rural	1.75 (1.51, 2.04)	<0.001	1.34 (1.13, 1.59)*	0.001
Education				
High school and below	1.69 (1.50, 1.90)	<0.001	1.28 (1.12, 1.46)†	<0.001
College or graduate school	1.40 (0.77, 2.55)	0.266	0.96 (0.47, 1.98)†	0.916
Average monthly household income, ¥				
<3000	1.66 (1.42, 1.94)	<0.001	1.33 (1.12, 1.59)‡	0.001
≥3000	1.45 (1.21, 1.73)	<0.001	1.16 (0.94, 1.42)‡	0.161
Anxiety disorders				
Place of residence				
Urban	1.61 (1.31, 1.97)	<0.001	1.41 (1.12, 1.79)*	0.004
Rural	1.73 (1.47, 2.04)	<0.001	1.53 (1.27, 1.84)*	<0.001
Education				
High school and below	1.71 (1.50, 1.95)	<0.001	1.47 (1.27, 1.70)†	<0.001
College or graduate school	1.79 (0.95, 3.35)	0.072	1.70 (0.80, 3.61)†	0.171
Average monthly household income, ¥				
<3000	1.67 (1.41, 1.98)	<0.001	1.45 (1.20, 1.75)‡	<0.001
≥3000	1.51 (1.23, 1.85)	<0.001	1.49 (1.18, 1.86)‡	<0.001

Values are odds ratios (95% confidence intervals).
 Adjusted model was adjusted for age, place of residence, education, employment status, marital status, average monthly household income, drinking, smoking, regular physical activity, body mass index, diabetes mellitus and dyslipidaemia.
 Participants who were not diagnosed with hypertension were considered as the reference group.
 *Adjusted model was not adjusted for place of residence.
 †Adjusted model was not adjusted for education.
 ‡Adjusted model was not adjusted for average monthly household income.

socioeconomic inequalities in health behaviours as one of the social health determinants.³² Furthermore, poverty, education, geographical and cultural factors have been reported to be associated with poor utilisation of health services.³³ Prior research also suggested that inequality in health status might be avoidable via adjustable factors including economic and education status and living facilities.¹⁹ Therefore, health education on the prevention and management of hypertension and mental disorders should be more focused on women with relatively low SES in order to minimise inequality in depressive disorders. Furthermore, policymakers should recognise and assess the relationship between hypertension, SES and mental health, and develop effective strategies and interventions to decrease mental health disparities with different geographical locations and diverse levels of education and income. Moreover, expanding access to health insurance is critical to early identification and treatment of hypertension and mental disorders, especially among low SES populations, which might help women with low SES improve their mental and physical health.

This study has several strengths. First, the sample size was relatively large. Second, the study used validated instruments to assess disorders of depression and anxiety. Third, the study comprehensively adjusted for potential confounders. There are also several limitations to be noted. First, our study cannot evaluate the causality between hypertension and the odds of depressive and anxiety disorders due to its cross-sectional design and the study only focused on women. Second, we only used urban–rural residency and levels of education and household income to measure SES and did not include other indicators. However, in China, these three indicators have been considered the most important predictors of SES and are widely used to assess SES.¹⁶ Finally, we used self-reported hypertension and did not classify drinking and physical activity in detail.

CONCLUSIONS

In conclusion, our study found that hypertension was associated with increased odds of depressive and anxiety

disorders among middle-aged and older women. Additionally, this study indicated that the impact of hypertension on depressive and anxiety disorders was more evident in women with poor SES, which emphasises the important role of SES in the relationship between hypertension and depressive and anxiety disorders. Effective strategies and actions for identification and management of hypertension and depressive and anxiety disorders should be developed and implemented in middle-aged and older women, especially in lower SES populations. Further studies are needed to testify our findings and illuminate the potential mechanisms underlying the link between hypertension and mental health.

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Contributors Conceptualisation: XueW, XZ and BS. Methodology: XueW. Software: XueW. Investigation: DG and XuW. Data curation: XueW and DG. Writing—original draft preparation: XueW. Writing—review and editing: XZ and BS. Project administration: XZ and BS. XZ is overall guarantor for the study and has access to the data. All authors have read and agreed to the published version of the manuscript.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Obtained from patient.

Ethics approval This study involves human participants and the protocol was approved by the Ethical Review Committee of the Chinese Center for Disease Control and Prevention (ethic code: 201810). Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

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Supplemental Table 1. Socioeconomic status of participants by depressive and anxiety disorders

	Depressive disorders			Anxiety disorders		
	No (n=7826)	Yes (n=2074)	<i>P</i> value	No (n=8388)	Yes (n=1512)	<i>P</i> value
Place of residence			<0.001			<0.001
Urban	4048 (51.7)	897 (43.3)		4340 (51.7)	605 (40.0)	
Rural	3778 (48.3)	1177 (56.7)		4048 (48.3)	907 (60.0)	
Education			0.370			0.410
High school and below	7206 (92.1)	1922 (92.7)		7726 (92.1)	1402 (92.7)	
College or graduate school	620 (7.9)	152 (7.3)		662 (7.9)	110 (7.3)	
Average monthly household income, CNY			<0.001			<0.001
<3000	3046 (38.9)	1072 (51.7)		3327 (39.7)	791 (52.3)	
≥3000	4780 (61.1)	1002 (48.3)		5061 (60.3)	721 (47.7)	

Abbreviation: CNY=China Yuan.

Supplemental Table 2. ORs (95% CIs) for depressive and anxiety disorders according to hypertension status in comparison with non-hypertensive participants in eastern China

	Unadjusted model		Adjusted model	
	OR (95% CIs)	<i>P</i> value	OR (95% CIs)	<i>P</i> value
Depressive disorders				
Place of residence				
Urban	1.66 (1.15, 2.39)	0.006	1.21 (0.79, 1.85) ^a	0.381
Rural	1.41 (1.03, 1.91)	0.030	1.19 (0.82, 1.73) ^a	0.368
Education				
High school and below	1.48 (1.17, 1.87)	0.001	1.25 (0.94, 1.65) ^b	0.123
College or graduate school	0.65 (0.08, 5.26)	0.688	0.20 (0.01, 2.78) ^b	0.230
Average monthly household income, CNY				
<3000	1.49 (1.05, 2.12)	0.025	1.29 (0.85, 1.95) ^c	0.239
≥3000	1.37 (0.99, 1.89)	0.055	1.20 (0.83, 1.75) ^c	0.334
Anxiety disorders				
Place of residence				
Urban	1.64 (1.07, 2.50)	0.023	1.31 (0.80, 2.13) ^a	0.282
Rural	1.57 (1.12, 2.19)	0.008	1.87 (1.24, 2.84) ^a	0.003
Education				
High school and below	1.55 (1.20, 2.02)	0.001	1.62 (1.19, 2.21) ^b	0.003
College or graduate school	-	-	-	-
Average monthly household income, CNY				
<3000	1.47 (0.98, 2.21)	0.064	1.52 (0.93, 2.50) ^c	0.096
≥3000	1.61 (1.14, 2.28)	0.006	1.70 (1.14, 2.54) ^c	0.010

Values are odds ratios (95% confidence intervals). Adjusted model was adjusted for age, place of residence, education, employment status, marital status, average monthly household income, drinking, smoking, regular physical activity, body mass index, diabetes mellitus and dyslipidemia. Participants who were not diagnosed with hypertension were considered as the reference group.

Abbreviation: OR=odds ratio; CI=confidence interval; CNY=China Yuan.

^a Adjusted model was not adjusted for place of residence.

^b Adjusted model was not adjusted for education.

^c Adjusted model was not adjusted for average monthly household income.

There is no participant having both anxiety disorders and hypertension in participant with education levels of college or graduate school in eastern China.

Supplemental Table 3. ORs (95% CIs) for depressive and anxiety disorders according to hypertension status in comparison with non-hypertensive participants in central China

	Unadjusted model		Adjusted model	
	OR (95% CIs)	<i>P</i> value	OR (95% CIs)	<i>P</i> value
Depressive disorders				
Place of residence				
Urban	1.59 (1.16, 2.19)	0.004	1.34 (0.93, 1.94) ^a	0.117
Rural	1.68 (1.28, 2.21)	<0.001	1.38 (1.09, 1.74) ^a	0.008
Education				
High school and below	1.66 (1.34, 2.04)	<0.001	1.25 (0.94, 1.65) ^b	0.123
College or graduate school	1.27 (0.41, 3.96)	0.675	0.77 (0.16, 3.80) ^b	0.479
Average monthly household income, CNY				
<3000	1.56 (1.14, 2.12)	0.005	1.38 (0.98, 1.94) ^c	0.069
≥3000	1.60 (1.21, 2.12)	<0.001	1.34 (0.97, 1.86) ^c	0.075
Anxiety disorders				
Place of residence				
Urban	1.52 (1.07, 2.50)	0.023	1.14 (0.72, 1.80) ^a	0.581
Rural	1.41 (1.04, 1.92)	0.026	1.38 (0.98, 1.95) ^a	0.066
Education				
High school and below	1.51 (1.18, 1.93)	0.001	1.29 (0.98, 1.70) ^b	0.068
College or graduate school	1.25 (0.35, 4.46)	0.733	0.92 (0.16, 5.24) ^b	0.925
Average monthly household income, CNY				
<3000	1.69 (1.19, 2.41)	0.003	1.44 (0.97, 2.13) ^c	0.070
≥3000	1.25 (0.89, 1.76)	0.195	1.19 (0.80, 1.75) ^c	0.393

Values are odds ratios (95% confidence intervals). Adjusted model was adjusted for age, place of residence, education, employment status, marital status, average monthly household income, drinking, smoking, regular physical activity, body mass index, diabetes mellitus and dyslipidemia. Participants who were not diagnosed with hypertension were considered as the reference group.

Abbreviation: OR=odds ratio; CI=confidence interval; CNY=China Yuan.

^a Adjusted model was not adjusted for place of residence.

^b Adjusted model was not adjusted for education.

^c Adjusted model was not adjusted for average monthly household income.

Supplemental Table 4. ORs (95% CIs) for depressive and anxiety disorders according to hypertension status in comparison with non-hypertensive participants in western China

	Unadjusted model		Adjusted model	
	OR (95% CIs)	<i>P</i> value	OR (95% CIs)	<i>P</i> value
Depressive disorders				
Place of residence				
Urban	1.55 (1.17, 2.05)	0.002	1.12 (0.80, 1.56) ^a	0.506
Rural	2.11 (1.65, 2.68)	<0.001	1.42 (1.08, 1.86) ^a	0.012
Education				
High school and below	1.91 (1.59, 2.31)	<0.001	1.29 (1.04, 1.60) ^b	0.019
College or graduate school	1.50 (0.67, 3.35)	0.325	1.08 (0.42, 2.78) ^b	0.879
Average monthly household income, CNY				
<3000	1.99 (1.60, 2.47)	<0.001	1.38 (1.08, 1.76) ^c	0.011
≥3000	1.37 (0.97, 1.96)	0.075	0.99 (0.66, 1.49) ^c	0.963
Anxiety disorders				
Place of residence				
Urban	1.78 (1.32, 2.41)	<0.001	1.83 (1.29, 2.61) ^a	<0.001
Rural	2.12 (1.64, 2.73)	<0.001	1.61 (1.22, 2.14) ^a	<0.001
Education				
High school and below	2.01 (1.65, 2.46)	<0.001	1.67 (1.33, 2.09) ^b	<0.001
College or graduate school	2.32 (1.03, 5.24)	0.043	2.28 (0.84, 6.21)	0.107
Average monthly household income, CNY				
<3000	1.93 (1.54, 2.43)	<0.001	1.55 (1.20, 2.01) ^c	<0.001
≥3000	1.86 (1.28, 2.69)	0.001	1.96 (1.29, 2.97) ^c	0.002

Values are odds ratios (95% confidence intervals). Adjusted model was adjusted for age, place of residence, education, employment status, marital status, average monthly household income, drinking, smoking, regular physical activity, body mass index, diabetes mellitus and dyslipidemia. Participants who were not diagnosed with hypertension were considered as the reference group.

Abbreviation: OR=odds ratio; CI=confidence interval; CNY=China Yuan.

^a Adjusted model was not adjusted for place of residence.

^b Adjusted model was not adjusted for education.

^c Adjusted model was not adjusted for average monthly household income.

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5-6
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-8
Bias	9	Describe any efforts to address potential sources of bias	6
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-8
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	8-9
		(b) Describe any methods used to examine subgroups and interactions	8-9
		(c) Explain how missing data were addressed	6
		(d) If applicable, describe analytical methods taking account of sampling strategy	n/a
		(e) Describe any sensitivity analyses	n/a
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9
		(b) Give reasons for non-participation at each stage	9
		(c) Consider use of a flow diagram	9
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9
		(b) Indicate number of participants with missing data for each variable of interest	6
Outcome data	15*	Report numbers of outcome events or summary measures	9
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9-10
		(b) Report category boundaries when continuous variables were categorized	8
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	10
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	10
Discussion			
Key results	18	Summarise key results with reference to study objectives	11-14
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14-15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	15
Generalisability	21	Discuss the generalisability (external validity) of the study results	15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.