RESEARCH ARTICLE

International Journal of Geriatric Psychiatry

The prevalence of depressive symptoms among older patients with hypertension in rural China

Jiang Xue[1], Shulin Chen[2], Hillary R. Bogner[3], Wan Tang[4], Lydia Li[5] and Yeates Conwell[6]

[1]Department of Psychology, Zhejiang University, Hangzhou, China
[2]Department of Psychology, Zhejiang University, Hangzhou, China
[3]Department of Family Medicine, University of Pennsylvania, Philadelphia, PA, USA
[4]Department of Biostatistics and Bioinformatics, Tulane University, New Orleans, LA, USA
[5]School of Social Work, University of Michigan, USA
[6]Department of Psychiatry, University of Rochester, Rochester, NY, USA
Correspondence to: S. Chen, E-mail: chenshulin@zju.edu.cn

Objective: The comorbidity of depression and hypertension (HTN) is common and complicates the management of both conditions. This study investigated the prevalence of depressive symptoms among older patients with HTN in rural China and explored the relationship between the two conditions.

Methods: The baseline data of older patients diagnosed with HTN included in the depression/HTN in Chinese Older Adults—Collaborations for Health Study were used for the analysis. The Chinese Older Adults—Collaborations for Health Study was conducted in rural villages of Tonglu County, Zhejiang Province, China. In all, 10 389 older village residents had HTN (57.2% female, mean age 71.5 ± 8.1 years). Blood pressure was measured by using a calibrated manual sphygmomanometer and stethoscope. Depressive symptom was measured by using the Chinese version of the nine-item Patient Health Questionnaire.

Results: Among 10 389 patients with HTN, 12.8% had significant depressive symptoms (nine-item Patient Health Questionnaire ≥ 10). Rates of significant depressive symptoms were 5.3% and 32.8% among patients with controlled and uncontrolled HTN (systolic blood pressure ≥ 140 and/or diastolic blood pressure ≥ 90), respectively ($\chi^2 = 8.701$, $p < 0.001$). Logistic regression analysis indicated that those in older age group (≥ 70 years) and with uncontrolled HTN have higher rates of significant depressive symptoms than those who are younger (age 60 to <70) and with controlled HTN.

Conclusion: Our findings show high rates of depressive symptoms among patients with HTN in rural China and higher rates of depressive symptoms among patients with uncontrolled HTN. These support the development and dissemination of integrative care approaches for older adults with HTN and depression in rural China.

Key words: prevalence; depressive symptoms; hypertension; older adults; rural China
History: Received 21 July 2016; Accepted 26 October 2016; Published online 28 November 2016 in Wiley Online Library (wileyonlinelibrary.com)
DOI: 10.1002/gps.4628

Introduction

China is the most populous country in the world, and over half of Chinese live in rural regions (Yearbook, 2014). While the pace of development is rapid in urban areas, rural regions lag behind (Xuechun, 2010). With more and more younger and middle-age adults moving to the cities for work, there is an increasing need for mental health care for older adults remaining in rural regions. Although it is well recognized that psychiatric comorbidity, especially depression, has a negative long-term impact on health outcomes for older adults with hypertension (HTN) (Adamenko, 1967; Musselman *et al.*, 1998; Sandstrom *et al.*, 2016; Smith *et al.*, 2013), to date, few studies have explored the relationship between depression and HTN in rural China.

Hypertension is a major risk factor for cardiovascular morbidity and mortality, representing two

thirds of all strokes and one half of all ischemic heart diseases (Jonas *et al.*, 1997). Approximately one fourth of adults have been diagnosed with HTN around the world, and the proportion will reach about one third by 2025 (Mittal and Singh, 2010). Many adults with HTN live in China, where the prevalence is up to 41.9%, and the prevalence is even higher in rural areas compared with that in urban areas (He, 2016; Li *et al.*, 2016).

Hypertension is often accompanied by somatic symptoms, a lower quality of life, and role impairment (He, 2016; Lewington *et al.*, 2016; Ong *et al.*, 2007). In addition,HTN is associated with psychological distress, as well as depression (Baldissera and Bueno, 2012; Kretchy *et al.*, 2014; Liao *et al.*, 2004; Tevie and Shaya, 2015). Depression is a treatable illness that disproportionally places older adults at risk for functional and cognitive decline. Depression is the leading cause of disability among patients with chronic diseases such as HTN, with an estimated 350 million people worldwide affected (Mittal and Singh, 2010) and a lifetime risk of 7% (Davidson *et al.*, 2000). Individuals suffering from depression experience functional impairment, poor clinical outcomes, and increased health care expenditures. At its worst, depression can lead to suicide and all-cause mortality (Markovitz *et al.*, 1993).

Many studies have addressed the interplay between HTN and depression. Epidemiologic studies have found that patients with HTN are more likely to develop depression, and clinical depression has also been found to be an independent risk factor for HTN (Davidson *et al.*, 2000; Jonas *et al.*, 1997; Markovitz *et al.*, 1993; Meurs *et al.*, 2015; Ong *et al.*, 2007). Furthermore, depression is associated with poor adherence to antihypertensive medications (Krousel-Wood and Frohlich, 2010), which results in up to 50% of treatment failures (Stephenson, 1999). Accordingly, patients with both HTN and depression have a higher risk of mortality compared with patients with a single condition (Hajjar *et al.*, 2006; Kayano *et al.*, 2015).

In general, HTN is a risk factor for depression, and depression complicates HTN management. However, the prevalence of depression in patients with HTN in rural China is unknown. This study investigated the prevalence of depressive symptoms in older patients with HTN by using baseline data from the depression/HTN in Chinese Older Adults —Collaborations for Health (COACH) Study. We took the opportunity afforded by the COACH study to evaluate the co-occurrence of HTN and depressive symptoms in rural China and the public health significance of addressing patients' mental health needs with coexisting HTN.

Methods

Setting and participants

Data for this study were taken from screening and baseline assessments conducted for the COACH study, an ongoing project funded by the National Institutes of Mental Health USA designed to compare collaborative depression care management with care as usual for the treatment of comorbid depression and HTN in Chinese older rural village residents (Conwell, 2016). COACH study subjects reside in rural villages of Tonglu County, one of 55 counties in Zhejiang Province. We selected Tonglu County as the study site because both its population size and average household income are at the mean of all counties in the province. In Zhejiang province, each village clinic has a standardized electronic medical record system (EMR) supported by the Zhejiang Provincial Center for Disease Control and Prevention in which each patient is registered. Each patient registered in the EMR of selected villages was a potential participant. Village doctors used the EMR to identify all patients over age 60 in their village who had a diagnosis of HTN. The village doctors then visited each potential participant, either in their homes or the village clinic, checked their blood pressure (BP) according to specified standards, and administered the Chinese version of nine-item Patient Health Questionnaire (PHQ-9). Those who screened positive for clinically significant depressive symptoms (PHQ-9$\geq$10) were invited to meet with the research team and provided written informed consent. The study protocol was approved by the Institutional Review Board of Zhejiang University. Data used in our analysis included the baseline data (including demographic characteristics) of the COACH study collected in years 2013 and 2014.

The inclusion criteria of the screening were as follows: (i) community-dwelling residents registered to the selected village; (ii) age $\geq$60 years, the typical retirement age in rural China; (iii) a chart diagnosis of HTN; (iv) capable of independent communication with interviewers; and (v) capable of giving informed consent. The study was approved by the human subject protections board of Zhejiang University.

Among the 12 914 patients with HTN diagnoses registered in their EMR (see Figure 1 for participant flow chart), 2525 were excluded because of the following: (i) 798 no longer lived in the village; (ii) 210 were

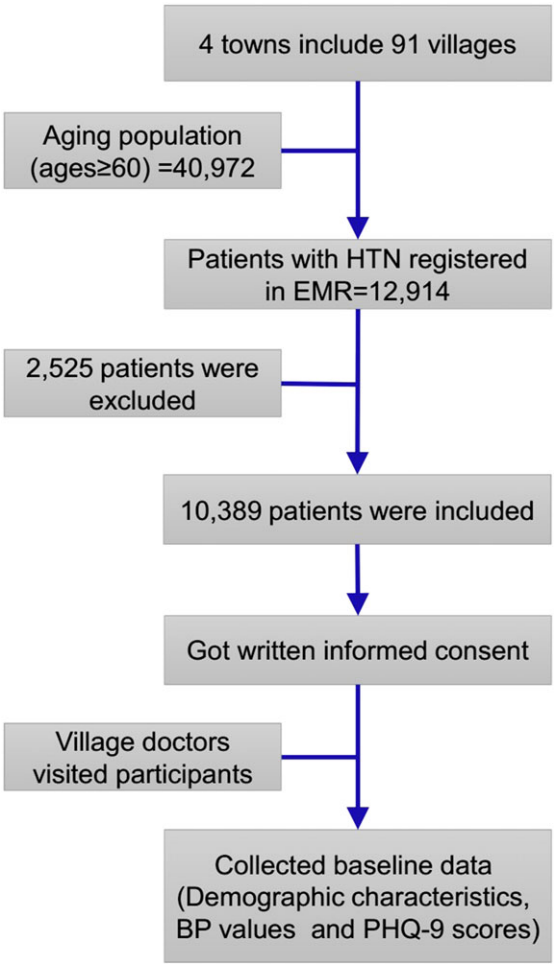

Figure 1 Participant procedure. [Colour figure can be viewed at wileyonlinelibrary.com]

unavailable for interview; (iii) 926 refused to participant; and (iv) 591 were excluded for other reasons. The total number of the participants available for analyses, therefore, was 10 389.

Measurements

The participants' BP measurements were obtained by their village doctors in their home or village clinics by using a calibrated manual sphygmomanometer and stethoscope (the quality of the devices was monitored every 6 months). All participants were tested three times for BP with a 2-min interval between each measurement. The average of the three BP readings was included in the data analysis. The BP readings distinguished two HTN conditions: those with controlled HTN (coded 0) and those with uncontrolled HTN (coded 1). The latter was defined as systolic BP (SBP) ≥140 and/or diastolic BP (DBP) ≥90.

The Chinese version of the PHQ-9, which has been shown to have good reliability and validity in community Chinese older persons, was used to measure depressive symptoms (Chen *et al.*, 2010). The original PHQ-9 was designed for the primary care settings (Kroenke *et al.*, 2001). As a screening tool, a score of ≥10 on the PHQ-9 has been suggested to indicate clinically significant depressive symptoms (used interchangeably with significant depressive symptoms here). We created a dichotomous variable to indicate severity of depressive symptom of the respondents (1 = clinically significant symptoms vs 0 = not clinically significant symptoms).

Data analysis

We performed a descriptive analysis by using the demographic data to examine the basic characteristics of our sample and the prevalence of clinically significant depressive symptoms. The correlation between the BP and the PHQ-9 scores was examined by using Pearson (Spearman) correlation, and a chi-square test was used to explore the interplay between uncontrolled HTN and significant depressive symptoms. Meanwhile, receiver operating characteristic curve (ROC) analyses were performed to explore the predictive relationship between HTN and significant depressive symptoms. As what the results of ROC analyses indicated, we chose the reading of SBP and HTN conditions (controlled vs uncontrolled HTN) as well as demographic characteristics as predictors in a logistic regression model, with significant depressive symptoms as the outcome. In addition, logistic regression was used to test the interaction effects of age groups (≥70 vs 60–70) and HTN conditions on significant depressive symptoms. Seventy was used to divide the sample because it was the median age. All analyses were performed by using the STATISTICAL ANALYSIS SYSTEM, version 9.4.

Results

Prevalence of significant depressive symptoms among patients with HTN

The number of older adults aged ≥60 in the studied villages was 40 974, 18.1% of the total population. Among these older village residents, 31.5% (12 914) had a diagnosis of HTN, and 80.4% (10 389) of these individuals with HTN were included in this study (Table 1). Of the 10389 study participants (57.2% female, mean age 71.5 ± 8.1 years), 12.8% had clinically

Table 1 Demographic characteristics of participants

Demographic characteristics	Participants
Mean age, y ± SD	71.5 ± 8.1
Women, *N* (%)	5942 (57.2)
Uncontrolled blood pressure, *N* (%)	2825 (27.2)
Depression in whole group, *N* (%)	1329 (12.8)
Depression in uncontrolled HTN, *N* (%)	926 (32.8)
Depression in controlled HTN, *N* (%)	403 (5.3)

HTN, hypertension.

significant depressive symptoms (PHQ-9 ≥ 10). Also, 27.2% of the 10 389 patients had uncontrolled HTN. The rate of significant depressive symptoms in patients with uncontrolled HTN (32.8%) was significantly greater than for those whose HTN was controlled (5.3%; $\chi^2 = 8.701$, $p < 0.001$).

Bivariate correlation between BP values and PHQ-9 score

Table 2 shows Pearson correlation coefficients for DBP, SBP, and PHQ-9 scores. All three variables were used as continuous variables. All coefficients were significant—patients with higher BP readings (both SBP and DBP) had higher PHQ-9 scores. This indicates positive correlations between BP and depressive symptoms.

ROC analysis between significant depressive symptoms and HTN

An ROC analysis using SBP as a test for significant depressive symptoms has an area under curve (AUC) of 0.76 with 95% confidence interval (0.74, 0.78). In statistics, an ROC analysis provides tools to select possible optimal models and to discard suboptimal ones independently from (and prior to specifying) the cost context or the class distribution; an AUC ≥0.70 implies good discrimination capability of the selected tool (Fawcett, 2006; Metz, 1978). This result of the ROC analysis was significant. Similarly, an additional ROC analysis using PHQ-9 score as a test for HTN condition also had a significant result with AUC = 0.75, 95% confidence interval (0.74, 0.76).

Logistic regression models with significant depressive symptoms as outcome

A logistic regression model with significant depressive symptoms as outcome and SBP, HTN conditions (controlled vs uncontrolled), and age and sex as predictors was conducted (Table 3). Age, SBP, and HTN conditions were significantly related to the incidence of having significant depressive symptoms. The model selection suggested that there may be interactions among age, SBP, and HTN conditions in predicting the outcome.

To test for the interaction effects, we created a product term of age group (≥70 vs 60–70) and HTN conditions (controlled vs not controlled). Table 4 presents the estimates of the logistic regression model that included the product term with the younger group as the reference group. The results indicate significant interaction effects between age and HTN conditions on the likelihood of having significant depressive symptoms. Specifically, those in the older age group (≥70) and with uncontrolled HTN were particularly at risk of having significant depressive symptoms, relative to those who are younger (age 60 to <70) and with controlled HTN.

Discussion

The principal finding of this study is that 12.8% of older patients with HTN (controlled and uncontrolled) and 32.8% of patients with uncontrolled HTN had clinically significant depressive symptoms in rural China. In contrast, the prevalence of depressive disorders among general older adults in China community was 6% (Chen *et al.*, 2005; Ma *et al.*, 2008). To our knowledge, this is the first study

Table 2 Pearson (Spearman) correlation coefficients between blood pressure and the PHQ-9 score

	Diastolic blood pressure	Systolic blood pressure	PHQ-9 score
Diastolic blood pressure	1.00	0.37*** (0.37***)	0.16*** (0.11***)
Systolic blood pressure	0.37*** (0.37***)	1.00	0.30*** (0.31***)
PHQ-9 score	0.16*** (0.11***)	0.30*** (0.31***)	1.00

PHQ-9, nine-item Patient Health Questionnaire.
***$p < 0.001$.

Table 3 Estimates from logistic regression using SBP, age, sex, and HTN conditions as predictors for significant depressive symptoms[a]

Parameter	DF	Estimate	Standard error	Wald chi-square	*p*
Intercept	1	−9.277	0.528	308.825	<0.001
SBP[b]	1	0.017	0.003	23.736	<0.001
Age (in years)	1	0.062	0.004	250.485	<0.001
Sex (male = 1)	1	−0.150	0.065	5.332	0.020
HTN conditions[c] (not controlled = 1)	1	1.755	0.099	317.524	<0.001

Note:
[a]Significant depressive symptoms were defined as PHQ-9 scores ≥10, coded 1 (vs 0 = PHQ-9 < 10).
[b]SBP, systolic blood pressure—used as a continuous variable.
[c]HTN, hypertension.

investigating the prevalence of clinically significant depressive symptoms among older patients with HTN in rural China and exploring its relationship with BP control.

Hypertension has a very high prevalence in rural China older adults, affecting more than 40% of older adults in rural areas (He, 2016; Li *et al.*, 2010; Li *et al.*, 2016), and only 45% of these older adults with HTN were recognized (Prince *et al.*, 2012). HTN has been listed as the top priority of the chronic disease management system in the national health policy of China (Kwan *et al.*, 2008). With its limited mental health resources, depression among Chinese patients with HTN has been inadequately addressed in China, especially in rural areas. The large percentage of patients with both uncontrolled HTN and clinically significant depressive symptoms in our study suggests the interplay between the two conditions—patients with HTN may be more likely to develop depression, and depression may be a risk factor for HTN. In addition, the significant positive correlation between BP and PHQ-9 scores indicated that patients with high BP are likely to have high PHQ-9 scores and vice versa. Furthermore, the results of ROC analyses suggest that SBP could be a predictor for depressive symptoms and that PHQ-9 score could be a predictor for uncontrolled HTN. The results of this study support the complex relationship between depression and HTN. In previous studies, SBP was found to be associated with mortality risks (Weidung *et al.*, 2015; Weidung *et al.*, 2016) which were also highly related to depression (Barefoot *et al.*, 1996; Bush *et al.*, 2001). Further studies focusing on the relationships among depression, SBP, and mortality risk are recommended.

We also found significant interaction effects of age group and HTN conditions in predicting having significant depressive symptoms. This finding indicates that those who have uncontrolled HTN and are 70 years old or older have higher odds of having significant depressive symptoms compared with individuals in other age group and HTN condition combinations. The combination of HTN and depression, therefore, as the first and second leading causes of disability adjusted life years by 2020 (Murray and Lopez, 1997), requires special attention, and the development of effective preventive intervention strategies for depression in this large subgroup of older adults is needed.

Mental illnesses account for a large proportion of the global burden of disease (Mathers *et al.*, 2008), and they commonly co-occur with chronic medical illnesses and interact in complex ways to increase the

Table 4 Logistic regression model modeling significant depressive symptoms[a]

Parameter	DF	Estimate	Standard error	Wald chi-square	*p*
Intercept	1	−3.713	0.149	618.792	<0.001
Age group[b]	1	1.610	0.126	164.675	<0.001
HTN conditions[c]	1	2.781	0.129	467.284	<0.001
Age group* HTN	1	−0.948	0.151	39.579	<0.001
Sex	1	−0.111	0.064	2.978	0.084

Note:
[a]Significant depressive symptoms were defined as PHQ-9 scores ≥10, coded 1 (vs 0 = PHQ-9 < 10).
[b]Age group was dichotomously coded (1 = >70 years vs 0 = 60 to ≤70). The younger group is the reference group.
[c]Age group* HTN means the term of the interaction between age and HTN. HTN, hypertension. HTN conditions were dichotomously coded (1 = not controlled, 0 = controlled).

severity, impede treatment, and worsen the outcomes of both disorders. Integrated care (e.g., colocating mental health providers in primary care settings) has been shown to help improve clinical outcomes and reduce costs (Smith *et al.*, 2007a). Evidence suggests that patients may be more engaged when mental health is integrated into care for physical health than other forms of care provision (Katon *et al.*, 2010). Approaches to integrating the health care of co-occurring mental and physical disorders in high-income countries have shown great promise to improve outcomes (Smith *et al.*, 2007b). Their effectiveness, however, has rarely been studied in low and middle-income countries, which is the objective of the ongoing COACH study, screening data for which were used here. The present analysis of the baseline data showed significant correlations between depressive symptom severity and HTN, especially uncontrolled HTN among older adults in rural China. These outcomes support the need to integrate the management of depression into chronic disease management for HTN in rural China.

This study has limitations. The sample was from one out of 55 counties in rural Zhejiang Province, so our findings may not be generalizable to urban or other rural areas. The data in this study were cross-sectional, which limited the analysis of the long-term associations between depression and HTN. Longitudinal studies would help to sort out the relationship between the two conditions.

Measuring BP in outpatient settings is challenging because many factors including individuals' mood status can affect the readings. It is unclear whether our measure of BP was biased; for example, people with depression may experience greater anxiety during visits to the doctor, and therefore have higher BP readings. Caution, therefore, should be exercised in interpreting the findings. In order to minimize measurement error, we used the average value of the three measurements.

Other limitations include the fact that we used no diagnostic assessment of depression. Nonetheless, the PHQ-9 is a valid measure of depressive symptom severity that is highly correlated with the diagnosis of major affective illness by the cutoff of ≥10. Both symptom severity and categorical diagnosis of depression are important to consider in their relationships to HTN. Future research should include a more complete diagnostic assessment of depression.

Finally, we had no information about the comorbidities including complications of HTN among this sample, which could influence the independence of the data from possible confounders, such as stroke, that are highly related with depression. We also did not have data about prescribed treatment or adherence to treatment for depression and HTN. Antidepressant medications can influence BP, and the results of the PHQ-9 could be influenced by the use of those drugs. We acknowledge that medication use can potentially confound the relationship between HTN conditions and depression symptoms.

In conclusion, our investigation adds new evidence to the literature on depressive symptoms in older adults with HTN. The prevalence of depressive symptoms in this group is high in rural China, and there is a significant association between HTN and depressive symptoms. Patients with uncontrolled HTN are much more likely to develop clinically significant depressive symptoms. Depressive symptoms may complicate HTN management, posing a significant clinical and public health challenge in rural China. Additional research is needed in the design and implementation of integrated care for management of older patients with comorbid HTN and depression.

Conflict of interest

None declared.

Key points

- The prevalence of depressive symptoms among patients with hypertension (HTN) in rural China is high, even higher in those with uncontrolled HTN. Integrated care for management of older patients with co-morbid HTN and depression may be necessary.
- There is a significant association between HTN and depressive symptoms. Patients with uncontrolled HTN are much more likely to develop clinically significant depressive symptoms. Longitudinal studies would help to determine the relationship between the two conditions.

Acknowledgements

The project was supported by the Fogarty International Center, the National Institutes of Health grant R01MH100298. This work was also supported by the Program for New Century Excellent Talents in University from the Ministry of Education China.

Reference

Adamenko R. 1967. Effect of depression on temporal arterial pressure in hypertension. *Vrach Delo* **10**: 25–28.

Baldissera VDA, Bueno SMV. 2012. Leisure and mental health in people with hypertension: convergence in health education. *Revista Da Escola De Enfermagem Da Usp* **46**: 380–387.

Barefoot JC, Helms MJ, Mark DB, *et al.* 1996. Depression and long-term mortality risk in patients with coronary artery disease*. *Am J Cardiol* **78**: 613–617.

Bush DE, Ziegelstein RC, Tayback M. 2001. Even minimal symptoms of depression increase mortality risk after acute myocardial infarction. *Am J Cardiol* **88**: 337–341.

Chen RL, Wei L, Hu Z, *et al.* 2005. Depression in older people in rural China. *Arch Intern Med* **165**: 2019–2025.

Chen SL, Chiu HL, Xu BH, *et al.* 2010. Reliability and validity of the PHQ-9 for screening late-life depression in Chinese primary care. *Int J Geriatr Psychiatry* **25**: 1127–1133.

Conwell, Y Chinese Older Adults—Collaboration in Health (COACH) Study. ClinicalTrials.gov (online). Available at: https://clinicaltrials.gov/ct2/show/NCT01938963. Accessed June 12, 2016.

Davidson K, Jonas BS, Dixon KE, Markovitz JH. 2000. Do depression symptoms predict early hypertension incidence in young adults in the CARDIA study? *Arch Intern Med* **160**: 1495–1500.

Fawcett T. 2006. An introduction to ROC analysis. *Pattern recognit lett* **27**: 861–874.

Hajjar I, Kotchen JM, Kotchen TA. 2006. Hypertension: trends in prevalence, incidence, and control. *Annu Rev Publ Health* **27**: 465–490.

He J. 2016. Hypertension in China: a large and increasing public health challenge. *J Hypertens* **34**: 29–31.

Jonas BS, Franks P, Ingram DD. 1997. Are symptoms of anxiety and depression risk factors for hypertension? Longitudinal evidence from the National Health and Nutrition Examination Survey I Epidemiologic Follow-up Study. *Arch Fam Med* **6**: 43–49.

Katon W, Lin EH, Von Korff M, *et al.* 2010. Integrating depression and chronic disease care among patients with diabetes and/or coronary heart disease: the design of the TEAMcare study. *Contemp Clin Trials* **31**: 312–322.

Kayano H, Koba S, Matsui T, *et al.* 2015. Impact of depression on masked hypertension and variability in home blood pressure in treated hypertensive patients. *Hypertens Res* **38**: 751–757.

Kretchy IA, Owusu-Daaku FT, Danquah SA. 2014. Mental health in hypertension: assessing symptoms of anxiety, depression and stress on anti-hypertensive medication adherence. *Int J Ment Health Syst* **8**: 1–6.

Kroenke K, Spitzer RL, Williams JBW. 2001. The PHQ-9 — validity of a brief depression severity measure. *J Gen Intern Med* **16**: 606–613.

Krousel-Wood MA, Frohlich ED. 2010. Hypertension and depression: coexisting barriers to medication adherence. *J Clin Hypertens (Greenwich)* **12**: 481–486.

Kwan TW, Yu C, Zheng Y, *et al.* 2008. Hypertension in China: past, present, and future. *Curr HypertensRev* **4**: 241–244.

Lewington S, Lacey B, Clarke R, *et al.* 2016. The burden of hypertension and associated risk for cardiovascular mortality in China. *JAMA Intern Med* **176**: 524–532.

Li H, Meng Q, Sun X, *et al.* 2010. Prevalence, awareness, treatment, and control of hypertension in rural China: results from Shandong Province. *J Hypertens* **28**: 432–438.

Li W, Gu H, Teo KK, *et al.* 2016. Hypertension prevalence, awareness, treatment, and control in 115 rural and urban communities involving 47 000 people from China. *J Hypertens* **34**: 39–46.

Liao J, Aguilar E, Butterbaugh G, *et al.* 2004. Identifying potential health risk factors of hypertension using mental stress tests in dialysis, intensive care, or emergency room nurses as compared to other nursing specialties. *J Invest Med* **52**: S264–S265.

Ma X, Xiang YT, Li SR, *et al.* 2008. Prevalence and sociodemographic correlates of depression in an elderly population living with family members in Beijing, China. *Psychol Med* **38**: 1723–1730.

Markovitz JH, Matthews KA, Kannel WB, Cobb JL, Dagostino RB. 1993. Psychological predictors of hypertension in the Framingham Study — is there tension in hypertension. *JAMA* **270**: 2439–2443.

Mathers C, Fat DM, Boerma JT. 2008. *The Global Burden of Disease: 2004 Update*. Geneva, Switzerland: World Health Organization.

Metz CE. 1978. *Basic Principles of ROC Analysis. Seminars in Nuclear Medicine*. Philadelphia, PA, USA: Elsevier; 283–298.

Meurs M, Groenewold NA, Roest AM, *et al.* 2015. The associations of depression and hypertension with brain volumes: independent or interactive? *Neuroimage Clin* **8**: 79–86.

Mittal BV, Singh AK. 2010. Hypertension in the developing world: challenges and opportunities. *Am J Kidney Dis* **55**: 590–598.

Murray CJ, Lopez AD. 1997. Alternative projections of mortality and disability by cause 1990–2020: Global Burden of Disease Study. *Lancet* **349**: 1498–1504.

Musselman DL, Evans DL, Nemeroff CB. 1998. The relationship of depression to cardiovascular disease — epidemiology, biology, and treatment. *Arch Gen Psychiatry* **55**: 580–592.

Ong KL, Cheung BM, Man YB, Lau CP, Lam KS. 2007. Prevalence, awareness, treatment, and control of hypertension among United States adults 1999–2004. *Hypertension* **49**: 69–75.

Prince MJ, Ebrahim S, Acosta D, *et al.* 2012. Hypertension prevalence, awareness, treatment and control among older people in Latin America, India and China: a 10/66 cross-sectional population-based survey. *J Hypertens* **30**: 177–187.

Sandstrom YK, Ljunggren G, Wandell P, Wahlstrom L, Carlsson AC. 2016. Psychiatric comorbidities in patients with hypertension — a study of registered diagnoses 2009–2013 in the total population in Stockholm County, Sweden. *J Hypertens* **34**: 414–420.

Smith DJ, Martin D, Mclean G, *et al.* 2013. Multimorbidity in bipolar disorder and undertreatment of cardiovascular disease: a cross sectional study. *BMC Med* **11**: 1–11.

Smith, SM, Allwright, S & O'dowd, T 2007a. Effectiveness of shared care across the interface between primary and specialty care in chronic disease management. The Cochrane Library.

Smith SM, Allwright S, O'dowd T. 2007b. Effectiveness of shared care across the interface between primary and specialty care in chronic disease management. *Cochrane Database Syst Rev* **3**: 1–56.

Stephenson J. 1999. Noncompliance may cause half of antihypertensive drug "failures". *JAMA* **282**: 313–314.

Tevie J, Shaya FT. 2015. Association between mental health and comorbid obesity and hypertension among children and adolescents in the US. *Eur Child Adolesc Psychiatry* **24**: 497–502.

Weidung B, Bostrom G, Toots A, *et al.* 2015. Blood pressure, gait speed, and mortality in very old individuals: a population-based cohort study. *JAMA* **16**: 208–214.

Weidung B, Littbrand H, Nordstr MP, Carlberg B, Gustafson Y. 2016. The association between SBP and mortality risk differs with level of cognitive function in very old individuals. *J Hypertens* **34**: 745–752.

Xuechun Z. 2010. The urban–rural differences of inflation in China. *J Finance Res* **10**: 004.

Yearbook, CS 2014. Beijing: China National Bureau of Statistics.