BMJ Open

Incidence of depressive symptoms and prospective relationship of depressive symptoms with baseline risk factors among mid-aged and elderly community-dwelling Chinese adults

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2019-029529
Article Type:	Research
Date Submitted by the Author:	06-Feb-2019
Complete List of Authors:	Wen, Yue; West China Hospital, Sichuan University, Department of Gastrointestinal Surgery Liu, Chunjuan; West China Hospital, Sichuan University, Department of Gastrointestinal Surgery Liao, Jing; West China Hospital, Sichuan University, Department of Gastrointestinal Surgery Yin, Yiqiong; West China Hospital, Sichuan University, Department of Gastrointestinal Surgery Wu, Dongmei; University of Electronic Science and Technology of China, The Clinical Hospital of Chengdu Brain Science Institute, MOE Key Lab for Neuroinformation; The Fourth People's Hospital of Chengdu & Chengdu Mental Health Center, Psychiatric Research Laboratory
Keywords:	depressive symptoms, incidence, mid-aged and older adults, China

Incidence of depressive symptoms and prospective relationship of depressive symptoms with baseline risk factors among mid-aged and elderly community-dwelling Chinese adults

Yue Wen, Chunjuan Liu, Jing Liao, Yiqiong Yin*, Dongmei Wu*

Correspondence should be made to:

Dongmei Wu, PhD, RN

Department of Nursing, The Clinical Hospital of Chengdu Brain Science Institute, MOE Key Lab for Neuroinformation, University of Electronic Science and Technology of China

Huli West 1st Lane, Chengdu, Sichuan Province, China, 610036.

Tel: 86-28-69515754

E-mail: wudongmei_2001@163.com

Yiqiong Yin, BN, RN

Chief Superintendent Nurse, Department of Gastrointestinal Surgery, West China Hospital, Sichuan University

37 Guoxue Xiang Street, Chengdu, Sichuan Province, China, 610041.

Tel: 86-28-85422877

E-mail: yiqiong489@163.com

*: Yiqiong Yin and Dongmei Wu were co-corresponding authors for this manuscript.

The full names, institutions, city, and country of all other co-authors:

Yue Wen, BN, RN

Supervisor Nurse, Department of Gastrointestinal Surgery, West China Hospital, Sichuan University

37 Guoxue Xiang Street, Chengdu, China, 610041. E-mail: wenyue19820327@163.com

Chunjuan Liu, BN, RN

Supervisor Nurse, Department of Gastrointestinal Surgery, West China Hospital, Sichuan University

37 Guoxue Xiang Street, Chengdu, China, 610041. E-mail: liuchunjuan2002@163.com

Jing Liao, MSN, RN

Senior Nurse, Department of Gastrointestinal Surgery, West China Hospital, Sichuan University

37 Guoxue Xiang Street, Chengdu, China, 610041. E-mail: m15982277765@163.com

Yiqiong Yin, BN, RN

Chief Superintendent Nurse, Department of Gastrointestinal Surgery, West China Hospital, Sichuan University

37 Guoxue Xiang Street, Chengdu, China, 610041. E-mail: yiqiong489@163.com

Dongmei Wu, PhD, RN

Assistant Professor, Department of Nursing, The Clinical Hospital of Chengdu Brain Science Institute, MOE Key Lab for Neuroinformation, University of Electronic Science and Technology of China

Huli West 1st Lane, Chengdu, China, 610036. Tel: 86-28-69515754. E-mail: wudongmei_2001@163.com

Word count: 5404

Abstract

Objectives. The purpose of this study was to examine the incidence of depressive symptoms, and determine if baseline risk factors conferred a risk for incident depression over time in a nationally representative sample of mid-aged and elderly Chinese population.

Design. This study was a secondary analysis of a prospective cohort from a nationally representative sample.

Setting. Community samples in 28 provinces of China were recruited from the baseline survey of the China Health and Retirement Longitudinal Study. A four-stage, stratified, cluster probability sampling strategy was used, which included 10,257 households with members aged 45 years or older and their spouse.

Participants. A total of 11,533 participants free of depressive symptoms at baseline were identified, and 10,288 were followed in either the second or the third waves of surveys. The current analyses were conducted among the 10,288 participants.

Primary and secondary outcome measures. Depressive symptoms were measured by the Center for Epidemiological Studies Depression Scale short form.

Results. The findings showed that the incidence of depressive symptoms in a 4-year follow-up was as high as 22.3%. The incidence was higher in rural areas and women. Furthermore, longer sleeping duration and better self-perceived health status were both associated with lower risk of depressive symptoms. On contrary, having diabetes and chronic kidney disease at baseline increased the risk of depressive symptoms. However, baseline body mass index was not associated with the onset of depressive symptoms in this population.

Conclusions. The findings of this study highlight the importance of developing an appropriate screening test to identify depressive symptoms for those who are vulnerable and ensure these individuals can receive early interventions for depression.

Key words: depressive symptoms, incidence, mid-aged and older adults, China

Strengths and limitations of this study

- Since the sample was representative of community-dwelling mid-aged and older Chinese adults, the study results can be generalized to mid-aged and older Chinese adults.
- This is the first study in China to estimate the incidence of depressive symptoms in a nationally representative population in China.
- Depressive symptoms were based on self-reports instead of clinically diagnosis. Therefore, information bias may be present. However, with longitudinal design, information bias in the current study was very likely to be non-differential.
- This study was a prospective analysis of baseline risk factors with depressive symptoms at follow-up, and no causal associations between these predictors and depressive symptoms can be drawn from the analysis.

Introduction

Depression has been recognized as a leading cause of disability and a major contributor to disease burdens globally [1]. An estimated 322 million adults had depression in 2015 worldwide, with nearly half of these people living in the South-East Asia and Western Pacific regions [2]. In China, about 4.2% adult population was estimated to be depressed, and the prevalence of depression reached a peak in older adulthood [2]. With fast economic growth, mid-aged adults are exposed to a high-stress lifestyle, which is thought to contribute significantly to an increase in mental health disorders in susceptible people [1]. Older adults, on the other hand, face noteworthy challenges to their life, including loss of independence, loss of social support due to the death of a spouse or weakened family connectedness (traditionally referred to as 'filial piety'), financial difficulties, and medical vulnerability [3]. Late-life depressive symptoms increase risk for significant impairment in social function [3], dementia [4], declined quality of life [5], and suicide [6]. They further complicate the prognosis of concurrent medical problems by increasing physical disability and decreasing motivation and adherence to prescribed medications and/or exercise or rehabilitation programs [7 8].

Although depression has come to be regarded as the common cold of psychosocial functioning in Western culture, mental disorders are still viewed as degrading not only to the patient, but also to the entire family in Chinese culture [9]. In addition, although effective interventions have been developed to alleviate symptoms of depression, depressive symptoms are often overlooked among the elderly, since most of them mistakenly consider these symptoms to be part of the normal ageing process [10]. Therefore, older adults may not actively seek medical treatment and leave their depressive symptoms undiagnosed or untreated. As persons aged 45 or older will increase from 32% to 51% of the total population from 2010 to 2040 in China [11],

reliable and up-to-date estimates of the proportion of this population affected by depressive symptoms are a key ingredient of effective health policy, planning, and evaluation.

Recently, a number of population-based studies have estimated prevalence of depressive symptoms among mid-aged and older Chinese adults [3 10 12 13]. Given that all these studies were cross-sectional, the incidence of depressive symptoms among mid-aged and older Chinese adults was not clear. Furthermore, despite a myriad of studies that examined a number of health conditions associated with an increased risk of mid- and late-life depressive symptoms, including chronic diseases, overweight/obesity, sleep duration, and self-perceived health status [3 13-16], the prospective relationships between these health conditions and depressive symptoms have not been well understood in this population. Such prospective relationships may provide further evidence on how baseline conditions may be predictive of depressive symptoms in the follow-up than cross-sectional analysis, especially given that these health conditions are expected to be a great challenge to an increasing aging population, and can often co-occur with depressive symptoms which may make these conditions worse [3]. A better understanding of these associations may also provide information that is useful in identifying patients who are vulnerable to mid-life or late-life depressive symptoms, and proactively assessing and treating modifiable risk factors during primary health care service.

Therefore, the purpose of this study was to examine the incidence of depressive symptoms among mid-aged and older adults in China, and determine if baseline sleep duration, body weight, self-perceived health status, and chronic conditions conferred a risk for incident depression over time, using baseline and four years of follow-up data from the China Health and Retirement Longitudinal Study (CHARLS).

Methods

Study Design

This study was a secondary analysis of prospective data from the CHARLS. The CHARLS is a nationwide, community-engaged, population-based epidemiological study of Chinese adults aged 45 years or older. The purpose of the CHARLS was to obtain detailed information regarding the dynamics of retirement and how it interacts with health, health insurance, and economic well-being. The CHARLS collects detailed information on a wide range of domains, including demographics, health status, physical measures, employment history, pension insurance, retirement, income, expenditures and assets [17]. The current study used data from baseline, the second, and the third waves of surveys.

Participants

The CHARLS national baseline survey was conducted in 28 provinces (Tibet, Ningxia, and Hainan were not included) across the country from May 2011 to March 2012. It was a survey of 10,257 households with members aged 45 years or older and their spouse, for a total of about 17,708 individuals. A four-stage, stratified, cluster probability sampling strategy was used to select eligible participants [17]. Details of the sampling procedure are published elsewhere [18]. The response rate for the survey was over 80% (94% in rural areas and 69% in urban areas) [17]. The baseline cohort of the CHARLS participants was followed up every two years with the same survey questionnaires and biomedical measures [17]. The second wave of the CHARLS was fielded between July 2013 and January 2014. Subjects in this study used the same inclusion and exclusion criteria as the original study. A total of 11,533 participants free of depressive symptoms at baseline were identified, of whom 9,329 were followed in the second wave of the CHARLS in 2013-2014, 9,157 were followed in the third wave survey in 2015-2016, and 10,288

were followed in either the second or the third waves of surveys. The current analyses were conducted among the 10,288 participants.

Patient and Public Involvement

In the current study, we used de-identified data from the CHARLS with no direct involvement of or interaction with participants in the design, recruitment or conduct of the original cohort study.

Variables, Definitions, and Measures

Depressive symptoms. The Center for Epidemiological Studies Depression Scale (CES-D) short form was used to measure depressive symptoms [19]. The CES-D short form consists of ten items, and each item was rated on a four-point Likert scale with answers ranging from 0 (rarely or none of the time) to 3 (most or all of the time) with the total possible summary score of 0 to 30. The time frame for the CES-D short form refers to the week prior to interview. Item 5 ("feeling hopeful about the future") and 8 ("feeling happy") were reversely scored before analysis. Higher scores corresponds to higher levels of depressive symptoms, and a score of 12 or higher has been used as the cut-off point for depressive symptoms [20].

The CES-D short form has been validated among a subsample of 742 CHARLS participants aged 60 years and older, showing adequate psychometric properties [20]. Confirmatory factor analysis showed that the two-factor model had the best fit. Depressive affect and somatic retardation were loaded as the first factor, and positive affect was loaded as the second factor. The two-factor structure varied across both genders in multi-group analysis (χ^2= 144.13, $p<0.001$). R^2 coefficient was used to measure the reliability of each item, and some of them differed between both gender groups. For example, depressive affect and somatic

retardation accounted for 37% and 64% of the variance in the depression indicator ("bothered") for the males and females, respectively [20].

Measure of health conditions associated with depressive symptoms. These factors included chronic conditions, overweight/obesity, sleep duration, and self-perceived health status. Information on chronic conditions was primarily based on self-reports except hypertension and diabetes. Participants were asked if they had been diagnosed with any of the following health conditions: arthritis, dyslipidemia, cancer (excluding minor skin cancers), liver diseases (except for fatty liver, tumors or cancer), cardiovascular diseases (heart attack, coronary heart disease, angina, congestive heart failure, or other heart problems), stoke, kidney disease (except for cancer or tumor), stomach or other gastrointestinal diseases (except for tumor or cancer), memory-related diseases, and asthma. Participants answered "yes" to these questions were defined as having these doctor-diagnosed conditions.

Hypertension was defined based on the most current guidelines from the American Heart Association, which have lowered the threshold of hypertension cut-off points to 130/80 mmHg [21]. A systolic blood pressure measurement of 130 mmHg and higher, or a diastolic measurement of 80 mmHg and higher, or 130/80 mmHg and higher, or taking antihypertensive medications including modern western medicine, traditional Chinese medicine, or using other treatment for hypertension was considered as having hypertension [21]. Blood pressure was measured three times (approximately 45 seconds apart) for each participant on the left arm in sitting position, using an electronic blood pressure monitor (Omron™ HEM-7112)[22].

The diagnosis of diabetes was based on the current guidelines from the American Diabetes Association (2018). Readings of 126 mg/dL or higher for fasting blood glucose ≥126 mg/dL, or readings of 200 mg/dL or higher for random blood glucose, or readings of 6.5% or

higher for glycated hemoglobin, or use of insulin, or taking oral hypoglycemic medications including traditional Chinese medicine, modern western medicine, or other diabetes treatment was considered as having diabetes [23].

Weight was measured to the nearest 0.1 kg using a digital scale (Omron™ HN-286, Yangzhou, China) on an even, uncarpeted surface, with participants removing heavy outer clothing. Height was measured without shoes to the nearest 0.1 cm using a stadiometer (Seca™213, Hangzhou, China). Body mass index (BMI, weight in kilograms divided by height in meters squared) was calculated from the participants' weight and height.

Self-perceived health status is a powerful indicator of the health status of elderly people [24]. It was measured based on self-reports to the following question, "Would you rate health as…",with five response options provided: excellent, very good, good, fair, and poor.

Sleep duration in hours was collected using a question, "During the past month, how many hours of actual sleep did you get at night (average hours for one night)? (This may be shorter than the number of hours you spend in bed.)"

Covariates. Factors that could confound the main association were identified a priori from current literature. Covariates included age, gender [3], education [25], and marital status [3 26]. Consistent with a prior CHARLS publication [27], education was categorized as illiterate or no formal education, some primary school but can read and write, primary school including home schooling, and middle school or above. Marital status was grouped as married versus not married.

Ethical Considerations

The CHARLS was approved by the Ethical Review Committee. The current study is a secondary analysis of the de-identified CHARLS public data. The Ethics Review Committee granted the current study exemption from review.

Statistical Analysis

Incidence of depressive symptoms. The incidence of depressive symptoms was analyzed taking into account the complex survey design and nonresponse rate in both estimates and the corresponding standard errors (SEs). Inverse probability weighting method was used to account for differential response rates. As described by the CHARLS guideline, response status (Yes or No) was first regressed on a dummy for gender, a dummy for age information, age (if known), a dummy for marital status, and a dummy for villages among all the eligible individuals in responded households. Then the inverse of the predicted probability from the regression model was calculated and rounded to one decimal [28]. Participants were categorized into 5-year age groups. SAS PROC SURVEYFREQ procedure was used to obtain the overall and gender specific incidence of depression among all the participants and by the 5-year age groups. In addition, overall and gender-specific depression incidence was estimated by rural and urban areas. We estimated the incidence of four outcomes of depressive symptoms: having depressive symptoms in the second wave of survey (2013-2014); having depressive symptoms in the third wave of survey (2015-2016); ever having depressive symptoms in the second or the third waves of survey; and consistently having depressive symptoms in both waves.

Prospective analysis. Baseline characteristics of the participants were summarized as frequency and percentage for categorical variables and mean and standard deviation or median and interquartile range for continuous variables. Associations of baseline health behaviors, including chronic conditions, overweight/obesity, sleep duration, and self-perceived health status, with the incidence of ever having depressive symptoms in 4 years of follow-up were evaluated by a multivariate logistic regression model, while controlling for all covariates as mentioned above. Odds ratios (ORs) and the corresponding 95% confidence intervals (CIs) were reported.

The SAS 9.4 (SAS Institute Inc., Cary, North Carolina) was used to perform the analyses. All the p values were two-sided, and $p<0.05$ was considered significant.

Results

Sample Characteristics

A total of 10,288 participants aged 45 years or older were included in the estimate of depressive symptoms incidence. As shown in Table 1, the average age of all participants was 58.5 years and roughly half participants (49.3%) were women. Most of the participants (73.3%) lived in rural areas and 60.6% participants had education of primary school or above. The majority of participants (90.0%) were married or living with a partner at the time of data collection. About a third of the participants (31.5%) were current smokers and 17.9% were current regular drinkers. Participants had an average BMI of 23.7 kg/m^2. The mean duration of sleep per night was 6.7 hours, and less than 20% of participants perceived their health as very good or excellent. The mean CES-D short form score was 5.1 at baseline.

Incidence of Depression

As shown in Table 2 and in Figure 1, the incidence of ever having depressive symptoms in 4 years was 22.3% (95% CI: 21.3%-23.3%). The incidence was much higher in rural areas than that in urban areas (25.7% vs. 15.3%). Women had higher incidence of depressive symptoms than men (27.9% vs. 16.7%). There is no clear pattern of the incidence of depressive symptoms over age groups (Figure 1). The incidence was highest among the 65-70 years of age group and lowest among the 45-50 years of age group.

Baseline Risk Factors And Incident Depression

As shown in Table 3, sleeping duration and self-perceived health status were both inversely associated with the risk of depressive symptoms. Specifically, participants with an hour

longer of sleeping had a 10% (95% CI: 7%-13%, p<0.0001) lower risk of developing depressive symptoms in 4 years follow up. Compared to individuals who perceived their health status as poor, those who perceived their health status as fair, good, very good, and excellent had 42% (95% CI: 39%-52%), 47% (95% CI: 36%-57%), 64% (95% CI: 54%-72%), and 62% (95% CI: 43%-74%) lower risk of developing depressive symptoms, respectively. In addition, two chronic conditions, diabetes (OR=1.19, 95% CI: 1.00-1.42, p=0.04) and chronic kidney disease (OR=1.37, 95% CI: 1.05-1.79, p=0.02) were associated with higher risk of depressive symptoms. However, baseline BMI was not associated with the onset of depressive symptoms in this population (OR=0.99, 95% CI: 0.97-1.01).

Discussion

Through analysis to data of a nationally representative sample of mid-aged and older Chinese adults, we found that the incidence of depressive symptoms in a 4-year follow-up was as high as 22.3%. Large disparities in the incidence of depressive symptoms were observed between rural and urban areas and between men and women. Furthermore, longer sleeping duration and better self-perceived health status were both associated with lower risk of depressive symptoms. On contrary, having diabetes and chronic kidney disease at baseline increased the risk of depressive symptoms. However, baseline BMI was not associated with depressive symptoms in this population.

This is the first study that examined the incidence of depressive symptoms in a nationally representative population in China. Our study found that in 4 years of follow-up, as high as 22.3% of the mid-aged and older Chinese adults developed depressive symptoms. Using the same database, a recent study reported that the prevalence of depressive symptoms at CHARLS baseline survey was up to 26.2% [12]. Collectively, these findings revealed that depressive

symptoms were a major public health challenge in China, and intervention programs should be developed to reduce the burden of depressive symptoms. Furthermore, large disparities were also observed between rural and urban residents and between men and women. In particular, women and residents living in rural areas were at a higher risk of developing depressive symptoms.

Individuals with longer sleep duration had lower risk of depressive symptoms. This finding is in line with previous studies [29 30]. Sleep disorders are often the presenting and core symptoms of depression [31]. However, treatment of depression did not resolve sleep symptoms which may confer a greater risk for depression recurrence and relapse [31]. Therefore, sleep deprivation should be at least considered as an early indicator of depressive symptoms. Individuals with sleep deprivation should be aware of their high risk of depressive symptoms and manage to improve the length of their sleeping.

Better self-perceived health status also reduced the risk of depressive symptoms in the current study. The finding is consistent with studies among other populations [32]. Self-perceived health is a powerful indicator of the overall health status of elderly people [24]. Many factors, including sociodemographic characteristics, chronic disease, functional status, social relationships, neighborhood environment, and nutrition pattern, were all important determinants of self-perceived health [24]. These factors are also associated with depressive symptoms. The current study adjusted most of the factors, except for functional status, social relationship, and nutrition pattern, which were not available in the CHARLS database. Still, poorer self-perceived health status was significantly associated with higher risk of depressive symptoms. Future studies additionally controlling for those factors will help to evaluate the contribution of those factors on the associations of self-perceived health status with depressive symptoms.

Furthermore, such study may also help delineate whether self-perceived health status may represent other factors that may lead to depressive symptoms.

Among 12 chronic conditions, baseline chronic kidney disease increased the risk of depressive symptoms at follow-up. Although the underlying mechanisms have not been well understood, some authors suggested that the psychosocial and biologic changes in dialysis may explain this relationship [33]. In addition to chronic kidney disease, baseline diabetes also conferred a higher risk of symptoms of depression over time in this study. Similar results were reported in a meta-analysis of 11 studies, which found that people with diabetes at baseline had a 24% higher risk of developing depression at follow-up compared to those without diabetes [34]. In addition, high prevalence of depression among people with diabetes and/or chronic kidney disease has also been observed in cross-sectional studies [35-37]. In concordance with these findings, this study added further evidence in a population of mid-aged and older Chinese population that compared to other chronic conditions at baseline, the two conditions were more likely to be associated with depressive symptoms over time.

Overweight/obesity is well established to interfere with mental health, with depressive symptoms being more common among overweight/obese individuals than their normal-weight counterparts, especially in overweight/obese women [38 39]. A meta-analysis of longitudinal studies further confirmed this relationship, in which excess weight at baseline increased a higher risk for incident depression at follow-up [40]. In contrast to these findings from Western and European countries, using data from a prospective survey of a large, representative sample of mid-aged and elderly community-dwelling residents in Mainland China, we did not find a relationship between baseline BMI and subsequent depressive symptoms over time. These inconsistent findings may suggest that because participants in the current study were predominantly low in BMI at baseline

(mean BMI was 23.7 kg/m^2), their likelihood of experiencing depressive symptoms may have been lower compared to those participants reported in Luppino et al. (2010). However, these are preliminary findings that need to be further investigated in future prospective studies in this population.

As the first study focused on the estimation of the incidence of depressive symptoms, the study has important strengths. First, since the sample was representative of community-dwelling mid-aged and older Chinese adults, the study results can be generalized to mid-aged and older Chinese adults. Second, a Chinese specific cut-off point of the CES-D short form score for depressive symptoms has been used, and the cut-off point was validated among middle-aged and older Chinese adults [20]. Therefore, our study provided more reliable estimate of the incidence of depressive symptoms. Third, strict quality control measures, including GPS matching, data checking, recording and checking interviews, and calling back participants, were implemented at every stage of the study to ensure data quality and reliability.

There were also some limitations in this study that should be acknowledged. First, depressive symptoms were based on self-reports instead of clinically diagnosis. Therefore, information bias may be present. However, with longitudinal design, information bias in the current study was very likely to be non-differential. Since non-differential misclassification generally bias the association estimates towards the null, our study findings were more robust. Second, nighttime sleep duration was also measured based on self-reports. The use of self-reported measures in the CHARLS surveys may have biased study results, since participants may consistently under- or overestimate their nighttime sleep duration [41]. Objective or direct measures of sleep duration should be used to increase precision and accuracy of self-report assessment. Finally, this study was a prospective analysis of baseline risk factors with depressive

symptoms at follow-up, and no causal associations between these predictors and depressive symptoms can be drawn from the analysis.

The findings of the current study have important implications for clinical practice. Health care professionals are especially encouraged to address the needs for better mental health in elderly population [42]. In view of the high incidence of depressive symptoms (22.3%) among mid-aged and elderly Chinese, the findings of this study highlight the importance of developing an appropriate screening test to identify depressive symptoms for those who are vulnerable and ensure these individuals can receive early interventions for depressive symptoms. The screening test should include items such as areas of living (rural or urban areas), gender, age groups, nighttime sleep duration, self-perceived health status, and certain chronic conditions, especially chronic kidney disease and diabetes. In addition, intervention strategies that address short nighttime sleep duration may be needed to alleviate depressive symptoms and improve mental health in this population. Intervention programs should also be prioritized to target at specific populations, such as women and residents living in rural areas, as these populations were at a higher risk of developing depressive symptoms. Finally, new patients with chronic kidney disease and diabetes may be needed to screen for depression at initial visit. Potential participants with serious depressive symptoms should be referred immediately to a mental health professional. Individuals with these two conditions are particularly vulnerable to the deleterious effects of affective symptoms, since depression is a known risk factor for noncompliance with medical treatment and adverse health outcomes [43 44].

Conclusions

To conclude, our study found a high incidence of depressive symptoms in 4 years of follow-up among a nationally representative mid-aged and older Chinese population. In addition, great disparities in the incidence of depressive symptoms were observed between individuals lived in rural and urban areas and between men and women. Furthermore, we identified that worse self-perceived health, shorter duration of sleeping, diabetes and chronic kidney disease at baseline increased the risk for depressive symptoms. These findings supported the importance of baseline status to longitudinal changes in depressive symptoms. Thus, interventions for vulnerable mid-aged and older adults should focus on addressing short nighttime sleep duration. These findings also revealed the burden of depressive symptoms in China, helped to prioritize health care resources and identified individuals at higher risk for depressive symptoms, such as those with chronic kidney disease and diabetes, or women and residents living in rural areas, so that early interventions can be implemented to prevent depressive symptoms.

Figure Legend

Figure 1. The Incidence of Depressive Symptoms in 4 Years of Follow-up among Participants of the CHARLS

Contributorship Statement

All authors contribute to the conception and design of this study. YW, YY, and DW were responsible for the design, analysis, drafting and revision of this manuscript. CL and JL were responsible for interpretation of data and preparation of the manuscript.

Competing Interests Statement

None declared.

Funding Statement

This work was supported by the Sichuan Science and Technology Program grant number 2018JY0306 to Dr. Dongmei Wu. The CHARLS is funded by Peking University, the National Natural Science Foundation of China, the Behavioral and Social Research Division of the National Institute on Aging, and the World Bank.

Patient Consent for Publication

Not required.

Data Sharing Statement

The study used a public data from the CHARLS that were obtained from the CHARLS home page at http://charls.pku.edu.cn/en.

References

1. Qin X, Wang S, Hsieh C. The prevalence of depression and depressive symptoms among adults in China: Estimation based on a National Household Survey. *China Economic Review* 2016 doi: 10.1016/j.chieco.2016.04.001
2. World Health Organization. Depression and other common mental disorders: Global health estimates. Geneva, Swiss: World Health Organization 2017.
3. Lei X, Sun X, Strauss J, et al. Depressive symptoms and SES among the mid-aged and elderly in China: Evidence from the China Health and Retirement Longitudinal Study national baseline. *Social Science & Medicine* 2014;120:224-32. doi: 10.1016/j.socscimed.2014.09.028 [published Online First: 2014/09/28]
4. Diniz BS, Butters MA, Albert SM, et al. Late-life depression and risk of vascular dementia and Alzheimer's disease: Systematic review and meta-analysis of community-based cohort studies. *The British journal of psychiatry : the journal of mental science* 2013;202:329-35. doi: 10.1192/bjp.bp.112.118307 [published Online First: 2013/05/03]
5. Sivertsen H, Bjørkløf GH, Engedal K, et al. Depression and quality of life in older persons: A review. *Dementia and geriatric cognitive disorders* 2015;40:311-39. doi: 10.1159/000437299
6. Wang CW, Chan CL, Yip PS. Suicide rates in China from 2002 to 2011: An update. *Social psychiatry and psychiatric epidemiology* 2014;49:929-41. doi: 10.1007/s00127-013-0789-5 [published Online First: 2013/11/19]
7. Holzapfel N, Lowe B, Wild B, et al. Self-care and depression in patients with chronic heart failure. *Heart & Lung* 2009;38:392-97. doi: 10.1016/j.hrtlng.2008.11.001 [published Online First: 2009/09/17]

8. Gonzalez JS, Safren SA, Delahanty LM, et al. Symptoms of depression prospectively predict poorer self-care in patients with type 2 diabetes. *Diabetetic Medicine* 2008;25:1102-07. doi: 10.1111/j.1464-5491.2008.02535.x [published Online First: 2009/02/03]

9. Zeng B, Sun W, Gary RA, et al. Towards a conceptual model of diabetes self-management among Chinese immigrants in the United States. *International journal of environmental research and public health* 2014;11:6727-42. doi: 10.3390/ijerph110706727 [published Online First: 2014/07/01]

10. Xu Y, Yang J, Gao J, et al. Decomposing socioeconomic inequalities in depressive symptoms among the elderly in China. *BMC public health* 2016;16:1214. doi: 10.1186/s12889-016-3876-1 [published Online First: 2016/12/03]

11. United Nations Deparment of Economic and Social Affais/Population Division. World population prospects: The 2012 revision, volume II: Demophic profiles. New York, NY: United Nations 2012.

12. Li C, Miles T, Shen L, et al. Early-life exposure to severe famine and subsequent risk of depressive symptoms in late adulthood: The China Health and Retirement Longitudinal Study. *The British journal of psychiatry : the journal of mental science* 2018;213:579-86. doi: 10.1192/bjp.2018.116 [published Online First: 2018/08/31]

13. Yu J, Li J, Cuijpers P, et al. Prevalence and correlates of depressive symptoms in Chinese older adults: A population-based study. *International journal of geriatric psychiatry* 2012;27:305-12. doi: 10.1002/gps.2721 [published Online First: 2011/05/04]

14. Alvaro PK, Roberts RM, Harris JK. A systematic review assessing bidirectionality between sleep disturbances, anxiety, and depression. *Sleep* 2013;36:1059-68. doi: 10.5665/sleep.2810 [published Online First: 2013/07/03]

15. Wilson-Genderson M, Heid AR, Pruchno R. Onset of multiple chronic conditions and depressive symptoms: A life events perspective. *Innovation in Aging* 2017;1:igx022-igx22. doi: 10.1093/geroni/igx022

16. Qian J, Li N, Ren X. Obesity and depressive symptoms among Chinese people aged 45 and over. *Scientific reports* 2017;7:45637. doi: 10.1038/srep45637

17. Zhao Y, Hu Y, Smith JP, et al. Cohort profile: The China Health and Retirement Longitudinal Study (CHARLS). *International journal of epidemiology* 2014;43:61-68. doi: 10.1093/ije/dys203 [published Online First: 2012/12/18]

18. Li C, Liu T, Sun W, et al. Prevalence and risk factors of arthritis in a middle-aged and older Chinese population: The China Health and Retirement Longitudinal Study. *Rheumatology (Oxford, England)* 2015;54:697-706. doi: 10.1093/rheumatology/keu391 [published Online First: 2014/10/08]

19. Andresen EM, Malmgren JA, Carter WB, et al. Screening for depression in well older adults: Evaluation of a short form of the CES-D (Center for Epidemiologic Studies Depression Scale). *American journal of preventive medicine* 1994;10(2):77-84. [published Online First: 1994/03/01]

20. Chen H, Mui AC. Factorial validity of the Center for Epidemiologic Studies Depression Scale short form in older population in China. *International psychogeriatrics / IPA* 2014;26:49-57. doi: 10.1017/s1041610213001701 [published Online First: 2013/10/16]

21. Whelton PK, Carey RM, Aronow WS, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: A report of the American College of Cardiology/American Heart Association Task Force on

Clinical Practice Guidelines. *Journal of the American College of Cardiology* 2018;71:e127-e248. doi: 10.1016/j.jacc.2017.11.006 [published Online First: 2017/11/18]

22. Zhao Y, Crimmins E, Hu P, et al. China Health And Retirement Longitudinal Study: 2011-2012 national baseline blood data users' guide. Beijing, China: China Center for Economic Research, Peking Universtiy 2014.

23. American Diabetes Association. 2. Classification and diagnosis of diabetes: Standards of medical care in diabetes-2018. *Diabetes care* 2018;41:S13-S27. doi: 10.2337/dc18-S002 [published Online First: 2017/12/10]

24. Machón M, Vergara I, Dorronsoro M, et al. Self-perceived health in functionally independent older people: Associated factors. *BMC geriatrics* 2016;16:66. doi: 10.1186/s12877-016-0239-9 [published Online First: 2016/03/11]

25. Bjelland I, Krokstad S, Mykletun A, et al. Does a higher educational level protect against anxiety and depression? The HUNT study. *Social science & medicine (1982)* 2008;66:1334-45. doi: 10.1016/j.socscimed.2007.12.019 [published Online First: 2008/02/01]

26. Cheng HG, Chen S, McBride O, et al. Prospective relationship of depressive symptoms, drinking, and tobacco smoking among middle-aged and elderly community-dwelling adults: Results from the China Health and Retirement Longitudinal Study (CHARLS). *Journal of affective disorders* 2016;195:136-43. doi: 10.1016/j.jad.2016.02.023 [published Online First: 2016/02/20]

27. Zuo M, Gan C, Liu T, et al. Physical predictors of cognitive function in individuals with hypertension: Evidence from the CHARLS basline survey. *Western journal of nursing research* 2018 doi: 10.1177/0193945918770794 [published Online First: 2018/05/11]

28. Zhao Y, Strauss J, Yang G, et al. China Health and Retirement Longitudinal Study-2011-2012 national baseline users's guide. Beijing, China: Peking University 2013.

29. Sun Y, Shi L, Bao Y, et al. The bidirectional relationship between sleep duration and depression in community-dwelling middle-aged and elderly individuals: Evidence from a longitudinal study. *Sleep medicine* 2018;52:221-29. doi: 10.1016/j.sleep.2018.03.011 [published Online First: 2018/06/05]

30. Li Y, Wu Y, Zhai L, et al. Longitudinal association of sleep duration with depressive symptoms among middle-aged and older Chinese. *Scientific reports* 2017;7:11794. doi: 10.1038/s41598-017-12182-0 [published Online First: 2017/09/20]

31. Nutt D, Wilson S, Paterson L. Sleep disorders as core symptoms of depression. *Dialogues in clinical neuroscience* 2008;10(3):329-36. [published Online First: 2008/11/05]

32. Cole MG, Dendukuri N. Risk factors for depression among elderly community subjects: A systematic review and meta-analysis. *American Journal of Psychiatry* 2003;160:1147-56. doi: 10.1176/appi.ajp.160.6.1147 [published Online First: 2003/06/05]

33. Sonikian M, Metaxaki P, Papavasileiou D, et al. Effects of interleukin-6 on depression risk in dialysis patients. *American journal of nephrology* 2010;31:303-08. doi: 10.1159/000285110 [published Online First: 2010/02/18]

34. Nouwen A, Winkley K, Twisk J, et al. Type 2 diabetes mellitus as a risk factor for the onset of depression: A systematic review and meta-analysis. *Diabetologia* 2010;53:2480-86. doi: 10.1007/s00125-010-1874-x [published Online First: 2010/08/17]

35. Anderson RJ, Freedland KE, Clouse RE, et al. The prevalence of comorbid depression in adults with diabetes: A meta-analysis. *Diabetes care* 2001;24(6):1069-78. [published Online First: 2001/05/26]

36. Palmer S, Vecchio M, Craig JC, et al. Prevalence of depression in chronic kidney disease: Systematic review and meta-analysis of observational studies. *Kidney international* 2013;84:179-91. doi: 10.1038/ki.2013.77 [published Online First: 2013/03/15]

37. Roy T, Lloyd CE. Epidemiology of depression and diabetes: A systematic review. *Journal of affective disorders* 2012;142 Suppl:S8-S21. doi: 10.1016/s0165-0327(12)70004-6 [published Online First: 2012/10/25]

38. Atlantis E, Baker M. Obesity effects on depression: Systematic review of epidemiological studies. *International journal of obesity (2005)* 2008;32:881-91. doi: 10.1038/ijo.2008.54 [published Online First: 2008/04/17]

39. de Wit L, Luppino F, van Straten A, et al. Depression and obesity: A meta-analysis of community-based studies. *Psychiatry research* 2010;178:230-35. doi: 10.1016/j.psychres.2009.04.015 [published Online First: 2010/05/14]

40. Luppino FS, de Wit LM, Bouvy PF, et al. Overweight, obesity, and depression: A systematic review and meta-analysis of longitudinal studies. *Archives of general psychiatry* 2010;67:220-29. doi: 10.1001/archgenpsychiatry.2010.2 [published Online First: 2010/03/03]

41. Li J, Cacchione PZ, Hodgson N, et al. Afternoon napping and cognition in Chinese older adults: Findings from the China Health and Retirement Longitudinal Study Baseline Assessment. *Journal of the American Geriatrics Society* 2017;65:373-80. doi: 10.1111/jgs.14368 [published Online First: 2016/12/21]

42. Avasthi A, Grover S. Clinical practice guidelines for management of depression in elderly. *Indian journal of psychiatry* 2018;60:S341-S62. doi: 10.4103/0019-5545.224474 [published Online First: 2018/03/15]

43. Zhang Y, Ting RZ, Yang W, et al. Depression in Chinese patients with type 2 diabetes: Associations with hyperglycemia, hypoglycemia, and poor treatment adherence. *Journal of diabetes* 2015;7:800-8008. doi: 10.1111/1753-0407.12238 [published Online First: 2014/10/29]

44. Fischer MJ, Kimmel PL, Greene T, et al. Elevated depressive affect is associated with adverse cardiovascular outcomes among African Americans with chronic kidney disease. *Kidney international* 2011;80:670-78. doi: 10.1038/ki.2011.153 [published Online First: 2011/06/03]

Tables

Table 1. Baseline characteristics of the CHARLS participants free of depressive symptoms

Variable	Distribution
N	10,288
age, years, mean (SD)	58.5 (9.8)
Male, n (%)	5845 (50.7%)
Living in rural areas, n (%)	8,440 (73.3%)
Education, n (%)	
No formal education or illiterate	2,736 (23.7%)
Some primary school	1,804 (15.7%)
Finished primary school	2,590 (22.5%)
Junior high school or above	4,394 (38.1%)
Currently married, n (%)	10,375 (90.0%)
Smoking status, n (%)	
Current smoker	3,629 (31.5%)
Former smoker	1,034 (9.0%)
Never smoking	6,868 (60.0%)
Drinking status, n (%)	
Regular drinkers	1,951 (17.9%)
Occasional drinkers	476 (4.4%)
Former drinkers	646 (5.9%)
Never drinking	7,833 (71.8%)
Weight, kg, mean (SD)	60 (11.8)
Height, m, mean (SD)	1.6 (0.1)
Body mass index, kg/m^2, mean (SD)	23.7 (4)
Sleeping duration, hours, mean (SD)	6.7 (1.7)
CES-D short form score	5.1 (3.3)
Self-perceived health status, n (%)	
Excellent	483 (4.2%)
Very good	1,744 (15.1%)
Good	4,136 (35.9%)
Fair	3,977 (34.5%)
Poor	1,187 (10.3%)
Chronic conditions, n (%)	
Hypertension	4,045 (40.3%)
Dyslipidemia	1,016 (9.0%)
Diabetes	1,210 (15.0%)
Cancer	97 (0.8%)
Liver disease	387 (3.4%)
Heart disease	1,162 (10.1%)
Stroke	188 (1.6%)
Kidney disease	563 (4.9%)

Gastrointestinal disease	2,180 (18.9%)
Dementia	105 (0.9%)
Arthritis	3,221 (28.0%)
Asthma	312 (2.7%)

Note. CES-D=Center for Epidemiologic Study of Depression short form; SD=standard deviation.

Table 2. Incidence of depressive symptoms among the CHARLS participants

	Ever having depressive Symptoms	Depressive symptoms in both visits 2 & 3	Depressive symptoms in 2 years	Depressive symptoms in 4 years
Overall	22.3 (21.3-23.3)	4.4 (4.0-4.9)	13.2 (12.5-14.1)	16.8 (15.9-17.7)
Rural	25.7 (24.6-26.8)	5.3 (4.8-5.8)	15.3 (14.3-16.2)	18.8 (17.8-19.8)
Urban	15.3 (13.4-17.2)	2.6 (1.9-3.3)	9.0 (7.4-10.6)	12.2 (10.4-14.1)
Men	16.7 (15.5-17.9)	3.0 (2.5-3.5)	9.9 (9.0-10.9)	12.2 (11.1-13.2)
Women	27.9 (26.4-29.4)	5.8 (5.1-6.6)	16.6 (15.3-17.9)	21.5 (20.1-22.9)

Table 3. Factors associated with the incidence of depressive symptoms in 4 years of follow-up

Variables	Odds ratio (95% confidence interval)	*P*
Age, per year older	0.98 (0.97-0.99)	**0.002**
Male vs. Female	0.60 (0.49-0.72)	**<.0001**
Education level		
No formal education or illiterate	ref.	**0.0004**
Some primary school (read and write)	1.06 (0.88-1.28)	
Finished primary school	0.88 (0.73-1.05)	
Junior high school or above	0.72 (0.60-0.87)	
Rural vs. Urban	1.66 (1.38-1.98)	**<.0001**
Not married vs. Married	1.26 (1.01-1.57)	**0.04**
Smoking status		
Current smokers	ref.	
Former smokers	0.69 (0.53-0.91)	**0.03**
Nonsmokers	0.96 (0.80-1.17)	
Drinking status		
Never drinkers		
Former drinkers	1.03 (0.78-1.36)	0.21
Occasional drinkers	0.83 (0.59-1.15)	
Regular drinkers	0.83 (0.68-1.01)	
Body mass index, per 1 kg/m^2 increase	0.99 (0.97-1.01)	0.16
Self-perceived health status		
Excellent	0.38 (0.26-0.57)	**<.0001**
Very good	0.36 (0.28-0.46)	
Good	0.53 (0.43-0.64)	
Fair	0.58 (0.48-0.71)	
Poor	ref.	
Sleep duration, per hour longer	0.90 (0.87-0.93)	**<.0001**
Hypertension (Y vs. N)	1.06 (0.92-1.21)	0.44
Dyslipidemia (Y vs. N)	0.92 (0.73-1.16)	0.50
Diabetes (Y vs. N)	1.19 (1.00-1.42)	**0.04**
Cancer (Y vs. N)	0.97 (0.47-2.01)	0.94
Chronic Lung Disease (Y vs. N)	1.16 (0.92-1.46)	0.22
Chronic Liver Disease (Y vs. N)	0.86 (0.61-1.21)	0.39
Heart Disease (Y vs. N)	1.05 (0.85-1.30)	0.63
Stroke (Y vs. N)	1.00 (0.61-1.64)	0.99
Chronic Kidney Disease (Y vs. N)	1.37 (1.05-1.79)	**0.02**
Chronic Digestive Disorders (Y vs. N)	1.09 (0.93-1.27)	0.28
Psychological Disorders (Y vs. N)	0.89 (0.43-1.85)	0.76
Dementia (Y vs. N)	1.19 (0.58-2.45)	0.64
Asthma (Y vs. N)	1.21 (0.83-1.77)	0.33

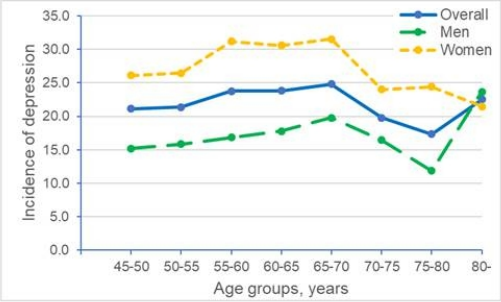


Figure 1. The Incidence of Depressive Symptoms in 4 Years of Follow-up among Participants of the CHARLS

254x190mm (96 x 96 DPI)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort 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	3
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	6-7
Objectives	3	State specific objectives, including any prespecified hypotheses	7
Methods			
Study design	4	Present key elements of study design early in the paper	8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	8-9
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	8
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	9-11
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	9
Bias	9	Describe any efforts to address potential sources of bias	17
Study size	10	Explain how the study size was arrived at	8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	12
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	12
		(*b*) Describe any methods used to examine subgroups and interactions	NA
		(*c*) Explain how missing data were addressed	NA
		(*d*) If applicable, explain how loss to follow-up was addressed	NA
		(*e*) Describe any sensitivity analyses	NA
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	8
		(b) Give reasons for non-participation at each stage	NA
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	13
		(b) Indicate number of participants with missing data for each variable of interest	NA
		(c) Summarise follow-up time (eg, average and total amount)	8
Outcome data	15*	Report numbers of outcome events or summary measures over time	NA
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	11, 13-14
		(*b*) Report category boundaries when continuous variables were categorized	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	14
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	17
Generalisability	21	Discuss the generalisability (external validity) of the study results	17
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	20

*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.

BMJ Open

Incidence and risk factors of depressive symptoms in four years of follow-up among mid-aged and elderly community-dwelling Chinese adults: Findings from the China health and Retirement Longitudinal Study

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2019-029529.R1
Article Type:	Research
Date Submitted by the Author:	14-May-2019
Complete List of Authors:	Wen, Yue; West China Hospital, Sichuan University, Department of Gastrointestinal Surgery Liu, Chunjuan; West China Hospital, Sichuan University, Department of Gastrointestinal Surgery Liao, Jing; West China Hospital, Sichuan University, Department of Gastrointestinal Surgery Yin, Yiqiong; West China Hospital, Sichuan University, Department of Gastrointestinal Surgery Wu, Dongmei; University of Electronic Science and Technology of China, The Clinical Hospital of Chengdu Brain Science Institute, MOE Key Lab for Neuroinformation; The Fourth People's Hospital of Chengdu & Chengdu Mental Health Center, Psychiatric Research Laboratory
Primary Subject Heading:	Mental health
Secondary Subject Heading:	Epidemiology
Keywords:	depressive symptoms, incidence, mid-aged and older adults, China

Incidence and risk factors of depressive symptoms in four years of follow-up among mid-aged and elderly community-dwelling Chinese adults: Findings from the China Health and Retirement Longitudinal Study

Yue Wen, Chunjuan Liu, Jing Liao, Yiqiong Yin*, Dongmei Wu*

Correspondence should be made to:

Dongmei Wu, PhD, RN

Department of Nursing, The Clinical Hospital of Chengdu Brain Science Institute, MOE Key Lab for Neuroinformation, University of Electronic Science and Technology of China

Huli West 1st Lane, Chengdu, Sichuan Province, China, 610036.

Tel: 86-28-69515754

E-mail: wudongmei_2001@163.com

Yiqiong Yin, BN, RN

Chief Superintendent Nurse, Department of Gastrointestinal Surgery, West China Hospital, Sichuan University

37 Guoxue Xiang Street, Chengdu, Sichuan Province, China, 610041.

Tel: 86-28-85422877

E-mail: yiqiong489@163.com

*: Yiqiong Yin and Dongmei Wu were co-corresponding authors for this manuscript.

The full names, institutions, city, and country of all other co-authors:

Yue Wen, BN, RN

Supervisor Nurse, Department of Gastrointestinal Surgery, West China Hospital, Sichuan University

37 Guoxue Xiang Street, Chengdu, China, 610041. E-mail: wenyue19820327@163.com

Chunjuan Liu, BN, RN

Supervisor Nurse, Department of Gastrointestinal Surgery, West China Hospital, Sichuan University

37 Guoxue Xiang Street, Chengdu, China, 610041. E-mail: liuchunjuan2002@163.com

Jing Liao, MSN, RN

Senior Nurse, Department of Gastrointestinal Surgery, West China Hospital, Sichuan University

37 Guoxue Xiang Street, Chengdu, China, 610041. E-mail: m15982277765@163.com

Yiqiong Yin, BN, RN

Chief Superintendent Nurse, Department of Gastrointestinal Surgery, West China Hospital, Sichuan University

37 Guoxue Xiang Street, Chengdu, China, 610041. E-mail: yiqiong489@163.com

Dongmei Wu, PhD, RN

Assistant Professor, Department of Nursing, The Clinical Hospital of Chengdu Brain Science Institute, MOE Key Lab for Neuroinformation, University of Electronic Science and Technology of China

Huli West 1st Lane, Chengdu, China, 610036. Tel: 86-28-69515754. E-mail: wudongmei_2001@163.com

Word count: 5404

Abstract

Objectives. The purpose of this study was to examine the incidence of depressive symptoms, and determine if baseline risk factors conferred a risk for incident depressive symptoms over time in a nationally representative sample of mid-aged and elderly Chinese population.

Design. This study was a secondary analysis of a prospective cohort from a nationally representative sample.

Setting. Community samples in 28 provinces of China were recruited from the baseline survey of the China Health and Retirement Longitudinal Study. A four-stage, stratified, cluster probability sampling strategy was used, which included 10,257 households with members aged 45 years or older and their spouse.

Participants. A total of 11,533 participants free of depressive symptoms at baseline were identified, and 10,288 were re-examined in either the first and/or the second follow-up surveys. The current analyses were conducted among the 10,288 participants.

Primary and secondary outcome measures. Depressive symptoms were measured by the Center for Epidemiological Studies Depression Scale short form.

Results. The findings showed that the incidence of depressive symptoms in a 4-year follow-up was as high as 22.3%. The incidence was higher in rural areas and women. Furthermore, longer sleeping duration and better self-perceived health status were both associated with lower risk of depressive symptoms. On contrary, having diabetes and chronic kidney disease at baseline increased the risk of depressive symptoms. However, baseline body mass index was not associated with the onset of depressive symptoms in this population.

Conclusions. The findings of this study highlight the importance of developing an appropriate screening test to identify depressive symptoms for those who are vulnerable and ensure these individuals can receive early interventions for depressive symptoms.

Key words: depressive symptoms, incidence, mid-aged and older adults, China

Strengths and limitations of this study

- Since the sample was representative of community-dwelling mid-aged and older Chinese adults, the study results can be generalized to mid-aged and older Chinese adults.
- This is the first study in China to estimate the incidence of depressive symptoms in a nationally representative population in China.
- Depressive symptoms were based on self-reports instead of clinically diagnosis. Therefore, information bias may be present. However, with longitudinal design, information bias in the current study was very likely to be non-differential.
- This study was a prospective analysis of baseline risk factors with depressive symptoms at follow-up, and no causal associations between these predictors and depressive symptoms can be drawn from the analysis.

Introduction

Depression has been recognized as a leading cause of disability and a major contributor to disease burdens globally [1]. An estimated 322 million adults had depression in 2015 worldwide, with nearly half of these people living in the South-East Asia and Western Pacific regions [2]. In China, about 4.2% adult population was estimated to be depressed, and the prevalence of depression reached a peak in older adulthood [2]. With fast economic growth, mid-aged adults are exposed to a high-stress lifestyle, which is thought to contribute significantly to an increase in mental health disorders in susceptible people [1]. Older adults, on the other hand, face noteworthy challenges to their life, including loss of independence, loss of social support due to the death of a spouse or weakened family connectedness (traditionally referred to as 'filial piety'), financial difficulties, and medical vulnerability [3]. Late-life depressive symptoms increase risk for significant impairment in social function [3], dementia [4], declined quality of life [5], and suicide [6]. They further complicate the prognosis of concurrent medical problems by increasing physical disability and decreasing motivation and adherence to prescribed medications and/or exercise or rehabilitation programs [7 8].

Although depression has come to be regarded as the common cold of psychosocial functioning in Western culture, mental disorders are still viewed as degrading not only to the patient, but also to the entire family in Chinese culture [9 10]. In addition, although effective interventions have been developed to alleviate symptoms of depression, depressive symptoms are often overlooked among the elderly, since most of them mistakenly consider these symptoms to be part of the normal ageing process [11]. Therefore, older adults may not actively seek medical treatment and leave their depressive symptoms undiagnosed or untreated. As persons aged 45 or older will increase from 32% to 51% of the total population from 2010 to 2040 in China [12],

reliable and up-to-date estimates of the proportion of this population affected by depressive symptoms are a key ingredient of effective health policy, planning, and evaluation.

Recently, a number of population-based studies have estimated prevalence of depressive symptoms among mid-aged and older Chinese adults [3 11 13 14]. Given that all these studies were cross-sectional, the incidence of depressive symptoms among mid-aged and older Chinese adults was not clear. Furthermore, despite a myriad of studies that examined a number of health conditions associated with an increased risk of mid- and late-life depressive symptoms, including chronic diseases, overweight/obesity, sleep duration, and self-perceived health status [3 14-17], the prospective relationships between these health conditions and depressive symptoms have not been well understood in this population. Such prospective relationships may provide further evidence on how baseline conditions may be predictive of depressive symptoms in the follow-up than cross-sectional analysis, especially given that these health conditions are expected to be a great challenge to an increasing aging population, and can often co-occur with depressive symptoms which may make these conditions worse [3]. A better understanding of these associations may also provide information that is useful in identifying patients who are vulnerable to mid-life or late-life depressive symptoms, and proactively assessing and treating modifiable risk factors during primary health care service.

Therefore, the purpose of this study was to examine the incidence of depressive symptoms among mid-aged and older adults in China, and determine if baseline sleep duration, body weight, self-perceived health status, and chronic conditions conferred a risk for incident depressive symptoms over time, using baseline and four years of follow-up data from the China Health and Retirement Longitudinal Study (CHARLS).

Methods

Study Design

This study was a secondary analysis of prospective data from the CHARLS. The CHARLS is a nationwide, community-engaged, population-based epidemiological study of Chinese adults aged 45 years or older. The purpose of the CHARLS was to obtain detailed information regarding the dynamics of retirement and how it interacts with health, health insurance, and economic well-being. The CHARLS collects detailed information on a wide range of domains, including demographics, health status, physical measures, employment history, pension insurance, retirement, income, expenditures and assets [18]. The current study used data from baseline, the first, and the second follow-up surveys.

Participants

The CHARLS national baseline survey was conducted in 28 provinces (Tibet, Ningxia, and Hainan were not included) across the country from May 2011 to March 2012. It was a survey of 10,257 households with members aged 45 years or older and their spouse, for a total of about 17,708 individuals. A four-stage, stratified, cluster probability sampling strategy was used to select eligible participants [18]. Details of the sampling procedure are published elsewhere [19]. The response rate for the survey was over 80% (94% in rural areas and 69% in urban areas) [18]. The baseline cohort of the CHARLS participants was followed up every two years with the same survey questionnaires and biomedical measures [18]. The first follow-up survey of the CHARLS was fielded between July 2013 and January 2014. Subjects in this study used the same inclusion and exclusion criteria as the original study. A total of 11,533 participants free of depressive symptoms at baseline were identified, of whom 9,329 participated in the first follow-up survey in 2013-2014, 9,157 were examined in the second follow-up survey in 2015-2016, and 10,288 were

followed in either the first or the second follow-up surveys. The current analyses were conducted among the 10,288 participants.

Patient and Public Involvement

In the current study, we used de-identified data from the CHARLS with no direct involvement of or interaction with participants in the design, recruitment or conduct of the original cohort study.

Variables, Definitions, and Measures

Depressive symptoms. The Center for Epidemiological Studies Depression Scale (CES-D) short form was used to measure depressive symptoms [20]. The CES-D short form consists of ten items, and each item was rated on a four-point Likert scale with answers ranging from 0 (rarely or none of the time) to 3 (most or all of the time) with the total possible summary score of 0 to 30. The time frame for the CES-D short form refers to the week prior to interview. Item 5 ("feeling hopeful about the future") and 8 ("feeling happy") were reversely scored before analysis. Higher scores corresponds to higher levels of depressive symptoms, and a score of 12 or higher has been used as the cut-off point for depressive symptoms [21].

The CES-D short form has been validated among a subsample of 742 CHARLS participants aged 60 years and older, showing adequate psychometric properties [21]. Confirmatory factor analysis showed that the two-factor model had the best fit. Depressive affect and somatic retardation were loaded as the first factor, and positive affect was loaded as the second factor. The two-factor structure varied across both genders in multi-group analysis (χ^2= 144.13, $p<0.001$). R^2 coefficient was used to measure the reliability of each item, and some of them differed between both gender groups. For example, depressive affect and somatic

retardation accounted for 37% and 64% of the variance in the depression indicator ("bothered") for the males and females, respectively [21].

Measure of health conditions associated with depressive symptoms. These factors included chronic conditions, overweight/obesity, sleep duration, and self-perceived health status. Information on chronic conditions was primarily based on self-reports except hypertension and diabetes. Participants were asked if they had been diagnosed with any of the following health conditions: arthritis, dyslipidemia, cancer (excluding minor skin cancers), liver diseases (except for fatty liver, tumors or cancer), cardiovascular diseases (heart attack, coronary heart disease, angina, congestive heart failure, or other heart problems), stoke, kidney disease (except for cancer or tumor), stomach or other gastrointestinal diseases (except for tumor or cancer), memory-related diseases, and asthma. Participants answered "yes" to these questions were defined as having these doctor-diagnosed conditions.

Hypertension was defined based on the most current guidelines from the American Heart Association, which have lowered the threshold of hypertension cut-off points to 130/80 mmHg [22]. A systolic blood pressure measurement of 130 mmHg and higher, or a diastolic measurement of 80 mmHg and higher, or 130/80 mmHg and higher, or taking antihypertensive medications including modern western medicine, traditional Chinese medicine, or using other treatment for hypertension was considered as having hypertension [22]. Blood pressure was measured three times (approximately 45 seconds apart) for each participant on the left arm in sitting position, using an electronic blood pressure monitor (Omron™ HEM-7112)[23].

The diagnosis of diabetes was based on the current guidelines from the American Diabetes Association (2018). Readings of 126 mg/dL or higher for fasting blood glucose ≥126 mg/dL, or readings of 200 mg/dL or higher for random blood glucose, or readings of 6.5% or

higher for glycated hemoglobin, or use of insulin, or taking oral hypoglycemic medications including traditional Chinese medicine, modern western medicine, or other diabetes treatment was considered as having diabetes [24].

Weight was measured to the nearest 0.1 kg using a digital scale (Omron™ HN-286, Yangzhou, China) on an even, uncarpeted surface, with participants removing heavy outer clothing. Height was measured without shoes to the nearest 0.1 cm using a stadiometer (Seca™213, Hangzhou, China). Body mass index (BMI, weight in kilograms divided by height in meters squared) was calculated from the participants' weight and height.

Self-perceived health status is a powerful indicator of the health status of elderly people [25]. It was measured based on self-reports to the following question, "Would you rate health as…",with five response options provided: excellent, very good, good, fair, and poor.

Sleep duration in hours was collected using a question, "During the past month, how many hours of actual sleep did you get at night (average hours for one night)? (This may be shorter than the number of hours you spend in bed.)"

Covariates. Factors that could confound the main association were identified a priori from current literature. Covariates included age, gender [3], education [26], and marital status [3 27]. Consistent with a prior CHARLS publication [28], education was categorized as illiterate or no formal education, some primary school but can read and write, primary school including home schooling, and middle school or above. Marital status was grouped as married versus not married.

Ethical Considerations

The CHARLS was approved by the Ethical Review Committee. The current study is a secondary analysis of the de-identified CHARLS public data. The Ethics Review Committee granted the current study exemption from review.

Statistical Analysis

Incidence of depressive symptoms. The incidence of depressive symptoms was analyzed taking into account the complex survey design and nonresponse rate in both estimates and the corresponding standard errors (SEs). Participants were categorized into 5-year age groups. SAS PROC SURVEYFREQ procedure was used to obtain the overall and gender specific incidence of depressive symptoms among all participants and by the 5-year age groups. In addition, overall and gender-specific incidence of depressive symptoms was estimated by rural and urban areas. We estimated the incidence of four outcomes of depressive symptoms: having depressive symptoms in the first follow-up survey (2013-2014); having depressive symptoms in the second follow-up survey (2015-2016); ever having depressive symptoms in the first or the second follow-up survey; and consistently having depressive symptoms in both follow-up surveys.

Prospective analysis. Baseline characteristics of the participants were summarized as frequency and percentage for categorical variables and mean and standard deviation or median and interquartile range for continuous variables. Associations of baseline health behaviors, including chronic conditions, overweight/obesity, sleep duration, and self-perceived health status, with the incidence of ever having depressive symptoms in 4 years of follow-up were evaluated by a multivariate logistic regression model, while controlling for all covariates as mentioned above. Odds ratios (ORs) and the corresponding 95% confidence intervals (CIs) were reported. The SAS 9.4 (SAS Institute Inc., Cary, North Carolina) was used to perform the analyses. All the p values were two-sided, and $p<0.05$ was considered significant.

Results

Sample Characteristics

A total of 10,288 participants aged 45 years or older were included in the estimate of depressive symptoms incidence. As shown in Table 1, the average age of all participants was 58.5 years and roughly half participants (49.3%) were women. Most of the participants (73.3%) lived in rural areas and 60.6% participants had education of primary school or above. The majority of participants (90.0%) were married or living with a partner at the time of data collection. About a third of the participants (31.5%) were current smokers and 17.9% were current regular drinkers. Participants had an average BMI of 23.7 kg/m^2. The mean duration of sleep per night was 6.7 hours, and less than 20% of participants perceived their health as very good or excellent. The mean CES-D short form score was 5.1 at baseline.

Incidence of Depressive Symptoms

As shown in Table 2 and in Figure 1, the incidence of ever having depressive symptoms in 4 years was 22.3% (95% CI: 21.3%-23.3%). The incidence was much higher in rural areas than that in urban areas (25.7% vs. 15.3%, $p<0.0001$). Women had higher incidence of depressive symptoms than men (27.9% vs. 16.7%, $p<0.0001$). There is no clear pattern of the incidence of depressive symptoms over age groups (Figure 1). The incidence was highest among the 65-70 years of age group and lowest among the 45-50 years of age group.

Baseline Risk Factors and Incident Depressive Symptoms

As shown in Table 3, in the fully adjusted multivariable logistic regression model, sleeping duration and self-perceived health status were both inversely associated with the risk of depressive symptoms. Specifically, participants with an hour longer of sleeping had a 10% (95% CI: 7%-13%, p<0.0001) lower risk of developing depressive symptoms in 4 years of follow up. Compared to individuals who perceived their health status as poor, those who perceived their health status as fair, good, very good, and excellent had 42% (95% CI: 39%-52%), 47% (95% CI:

36%-57%), 64% (95% CI: 54%-72%), and 62% (95% CI: 43%-74%) lower risk of developing depressive symptoms, respectively. In addition, three chronic conditions, diabetes (OR=1.19, 95% CI: 1.00-1.42, p=0.04), chronic kidney disease (OR=1.37, 95% CI: 1.05-1.79, p=0.02), chronic digestive disorders (OR=1.15, 95% CI: 1.01-1.31, p=0.04), and arthritis (OR=1.43, 95% CI: 1.28-1.61, p<0.0001) were associated with higher risk of depressive symptoms. However, baseline BMI was not associated with the onset of depressive symptoms in this population (OR=0.99, 95% CI: 0.97-1.01). Chronic lung disease (p=0.001), chronic liver disease (p=0.004), and asthma (p=0.02) were positively associated with incidence of depressive disorder in the raw analysis, but became non-significant in the fully adjusted model (all p>0.05).

Discussion

Through analysis to data of a nationally representative sample of mid-aged and older Chinese adults, we found that the incidence of depressive symptoms in a 4-year follow-up was as high as 22.3%. Large disparities in the incidence of depressive symptoms were observed between rural and urban areas and between men and women. Furthermore, longer sleeping duration and better self-perceived health status were both associated with lower risk of depressive symptoms. On contrary, having diabetes and chronic kidney disease at baseline increased the risk of depressive symptoms. However, baseline BMI was not associated with depressive symptoms in this population.

This is the first study that examined the incidence of depressive symptoms in a nationally representative population in China. Our study found that in 4 years of follow-up, as high as 22.3% of the mid-aged and older Chinese adults developed depressive symptoms. Using the same database, a recent study reported that the prevalence of depressive symptoms at CHARLS baseline survey was up to 26.2% [13]. Collectively, these findings revealed that depressive

symptoms were a major public health challenge in China, and intervention programs should be developed to reduce the burden of depressive symptoms. Furthermore, large disparities were also observed between rural and urban residents and between men and women. In particular, women and residents living in rural areas were at a higher risk of developing depressive symptoms.

Individuals with longer sleep duration had lower risk of depressive symptoms. This finding is in line with previous studies [29 30]. Sleep disorders are often the presenting and core symptoms of depression [31]. However, treatment of depression did not resolve sleep symptoms, which may confer a greater risk for depression recurrence and relapse [31]. Therefore, sleep deprivation should be at least considered as an early indicator of depressive symptoms. Individuals with sleep deprivation should be aware of their high risk of depressive symptoms and manage to improve the length of their sleeping.

Better self-perceived health status also reduced the risk of depressive symptoms in the current study. The finding is consistent with studies among other populations [32 33]. Self-perceived health is a powerful indicator of the overall health status of elderly people [25]. Many factors, including sociodemographic characteristics, chronic disease, functional status, social relationships, neighborhood environment, and nutrition pattern, were all important determinants of self-perceived health [25]. These factors are also associated with depressive symptoms. The current study adjusted most of the factors, except for functional status, social relationship, and nutrition pattern, which were not available in the CHARLS database. Still, poorer self-perceived health status was significantly associated with higher risk of depressive symptoms. Future studies additionally controlling for those factors will help to evaluate the contribution of those factors on the associations of self-perceived health status with depressive symptoms. Furthermore, such study may also help delineate whether self-perceived health status may

represent other factors that may lead to depressive symptoms. Finally, individuals with depressive disorders were more likely to report poor self-perceived health [34 35]. Therefore, there might be a bidirectional association between depressive symptoms and self-perceived health. Future studies examining the bi-directional relationship are warranted.

Among 12 chronic conditions, baseline chronic kidney disease increased the risk of depressive symptoms at follow-up. Although the underlying mechanisms have not been well understood, some authors suggested that the psychosocial and biologic changes in dialysis may explain this relationship [36]. In addition to chronic kidney disease, baseline diabetes also conferred a higher risk of symptoms of depression over time in this study. Similar results were reported in a meta-analysis of 11 studies, which found that people with diabetes at baseline had a 24% higher risk of developing depression at follow-up compared to those without diabetes [37]. In addition, high prevalence of depression among people with diabetes and/or chronic kidney disease has also been observed in cross-sectional studies [38-40]. In concordance with these findings, this study added further evidence that compared to other chronic conditions at baseline, baseline chronic disease and diabetes were more likely to be associated with depressive symptoms over time in a population of mid-aged and older Chinese population.

Overweight/obesity is well established to interfere with mental health, with depressive symptoms being more common among overweight/obese individuals than their normal-weight counterparts, especially in overweight/obese women [41 42]. A meta-analysis of longitudinal studies further confirmed this relationship, in which excess weight at baseline increased a higher risk for incident depression at follow-up [43]. In contrast to these findings from Western and European countries, using data from a prospective survey of a large, representative sample of mid-aged and elderly community-dwelling residents in Mainland China, we did not find a relationship between

baseline BMI and subsequent depressive symptoms over time. These inconsistent findings may suggest that because participants in the current study were predominantly low in BMI at baseline (mean BMI was 23.7 kg/m^2), their likelihood of experiencing depressive symptoms may have been lower compared to those participants reported in Luppino et al [43]. However, these are preliminary findings that need to be further investigated in future prospective studies in this population.

The study has several important strengths. First, to the best of our knowledge, this is the first study to estimate incidence of depressive symptoms in a nationally representative sample of middle-aged and older Chinese adults. Previous studies have focused on the estimation of depressive symptoms prevalence [44 45] or investigated the incidence of depressive symptoms in a regional sample [46]. Second, since the sample was representative of community-dwelling mid-aged and older Chinese adults, the results can be generalized to mid-aged and older Chinese adults. Third, a Chinese specific cut-off point of the CES-D short form score for depressive symptoms has been used, and the cut-off point was validated among middle-aged and older Chinese adults [21]. Therefore, our study provided more reliable estimate of the incidence of depressive symptoms. Finally, strict quality control measures, including GPS matching, data checking, recording and checking interviews, and calling back participants, were implemented at each stage of the study to ensure data quality and reliability.

There were also some limitations in this study that should be acknowledged. First, depressive symptoms were based on self-reports instead of clinically diagnosis. Therefore, information bias may be present. However, with longitudinal design, information bias in the current study was very likely to be non-differential. Since non-differential misclassification generally bias the association estimates towards the null, our study findings were more robust.

Second, nighttime sleep duration was also measured based on self-reports. The use of self-reported measures in the CHARLS surveys may have biased study results, since participants may consistently under- or overestimate their nighttime sleep duration [47]. Objective or direct measures of sleep duration should be used to increase precision and accuracy of self-report assessment. Finally, this study was a prospective analysis of baseline risk factors with depressive symptoms at follow-up, and no causal associations between these predictors and depressive symptoms can be drawn from the analysis.

The findings of the current study have important implications for clinical practice. Health care professionals are especially encouraged to address the needs for better mental health in elderly population [48]. In view of the high incidence of depressive symptoms (22.3%) among mid-aged and elderly Chinese, the findings of this study highlight the importance of developing an appropriate screening test to identify depressive symptoms for those who are vulnerable and ensure these individuals can receive early interventions for depressive symptoms. The screening test should include items such as areas of living (rural or urban areas), gender, age groups, nighttime sleep duration, self-perceived health status, and certain chronic conditions, especially chronic kidney disease and diabetes. In addition, intervention strategies that address short nighttime sleep duration may be used to alleviate depressive symptoms and improve mental health in this population. Intervention programs should also be prioritized to target at specific populations, such as women and residents living in rural areas, as these populations were at a higher risk of developing depressive symptoms. Finally, new patients with chronic kidney disease and diabetes may be needed to screen for depression at initial visit. Potential participants with serious depressive symptoms should be referred immediately to a mental health professional. Individuals with these two conditions are particularly vulnerable to the deleterious effects of

affective symptoms, since symptoms of depression is a known risk factor for noncompliance with medical treatment and adverse health outcomes [49 50].

Conclusions

To conclude, our study found a high incidence of depressive symptoms in 4 years of follow-up among a nationally representative mid-aged and older Chinese population. In addition, great disparities in the incidence of depressive symptoms were observed between individuals lived in rural and urban areas and between men and women. Furthermore, we identified that worse self-perceived health, shorter duration of sleeping, diabetes and chronic kidney disease at baseline increased the risk for depressive symptoms. These findings supported the importance of baseline status to longitudinal changes in depressive symptoms. Thus, interventions for vulnerable mid-aged and older adults should focus on addressing short nighttime sleep duration. These findings also help identify individuals at higher risk for depressive symptoms, such as those with chronic kidney disease and diabetes, or women and residents living in rural areas, so that early interventions can be implemented to prevent depressive symptoms.

Figure Legend

Figure 1. The Incidence of Depressive Symptoms in 4 Years of Follow-up among Participants of the CHARLS

Contributorship Statement

All authors contribute to the conception and design of this study. YW, YY, and DW were responsible for the design, analysis, drafting and revision of this manuscript. CL and JL were responsible for interpretation of data and preparation of the manuscript.

Competing Interests Statement

None declared.

Funding Statement

This work was supported by the Sichuan Science and Technology Program grant number 2018JY0306 to Dr. Dongmei Wu. The CHARLS is funded by Peking University, the National Natural Science Foundation of China, the Behavioral and Social Research Division of the National Institute on Aging, and the World Bank.

Acknowledgments

The authors would gratefully acknowledge the assistance Dr. Tingting Liu, an assistant professor at University of Arkansas Eleanor Mann School of Nursing for editing the manuscript.

Patient Consent for Publication

Not required.

Data Sharing Statement

The study used a public data from the CHARLS that were obtained from the CHARLS home page at http://charls.pku.edu.cn/en.

References

1. Qin X, Wang S, Hsieh C. The prevalence of depression and depressive symptoms among adults in China: Estimation based on a National Household Survey. *China Economic Review* 2016 doi: 10.1016/j.chieco.2016.04.001
2. World Health Organization. Depression and other common mental disorders: Global health estimates. Geneva, Swiss: World Health Organization 2017.
3. Lei X, Sun X, Strauss J, et al. Depressive symptoms and SES among the mid-aged and elderly in China: Evidence from the China Health and Retirement Longitudinal Study national baseline. *Social Science & Medicine* 2014;120:224-32. doi: 10.1016/j.socscimed.2014.09.028 [published Online First: 2014/09/28]
4. Diniz BS, Butters MA, Albert SM, et al. Late-life depression and risk of vascular dementia and Alzheimer's disease: Systematic review and meta-analysis of community-based cohort studies. *The British journal of psychiatry : the journal of mental science* 2013;202:329-35. doi: 10.1192/bjp.bp.112.118307 [published Online First: 2013/05/03]
5. Sivertsen H, Bjørkløf GH, Engedal K, et al. Depression and quality of life in older persons: A review. *Dementia and geriatric cognitive disorders* 2015;40:311-39. doi: 10.1159/000437299
6. Wang CW, Chan CL, Yip PS. Suicide rates in China from 2002 to 2011: An update. *Social psychiatry and psychiatric epidemiology* 2014;49:929-41. doi: 10.1007/s00127-013-0789-5 [published Online First: 2013/11/19]
7. Holzapfel N, Lowe B, Wild B, et al. Self-care and depression in patients with chronic heart failure. *Heart & Lung* 2009;38:392-97. doi: 10.1016/j.hrtlng.2008.11.001 [published Online First: 2009/09/17]

8. Gonzalez JS, Safren SA, Delahanty LM, et al. Symptoms of depression prospectively predict poorer self-care in patients with type 2 diabetes. *Diabetetic Medicine* 2008;25:1102-07. doi: 10.1111/j.1464-5491.2008.02535.x [published Online First: 2009/02/03]

9. Zeng B, Sun W, Gary RA, et al. Towards a conceptual model of diabetes self-management among Chinese immigrants in the United States. *International journal of environmental research and public health* 2014;11:6727-42. doi: 10.3390/ijerph110706727 [published Online First: 2014/07/01]

10. He P, Hu Y, Li C, et al. Predictors of Depressive Symptoms Among Mid-Aged and Older Men With Diabetes in China. *Research and theory for nursing practice* 2019;33(1):6-22. doi: 10.1891/1541-6577.33.1.6 [published Online First: 2019/02/24]

11. Xu Y, Yang J, Gao J, et al. Decomposing socioeconomic inequalities in depressive symptoms among the elderly in China. *BMC public health* 2016;16:1214. doi: 10.1186/s12889-016-3876-1 [published Online First: 2016/12/03]

12. United Nations Deparment of Economic and Social Affais/Population Division. World population prospects: The 2012 revision, volume II: Demophic profiles. New York, NY: United Nations 2012.

13. Li C, Miles T, Shen L, et al. Early-life exposure to severe famine and subsequent risk of depressive symptoms in late adulthood: The China Health and Retirement Longitudinal Study. *British Journal of Psychiatry* 2018;213:579-86. doi: 10.1192/bjp.2018.116 [published Online First: 2018/08/31]

14. Yu J, Li J, Cuijpers P, et al. Prevalence and correlates of depressive symptoms in Chinese older adults: A population-based study. *International journal of geriatric psychiatry* 2012;27:305-12. doi: 10.1002/gps.2721 [published Online First: 2011/05/04]

15. Alvaro PK, Roberts RM, Harris JK. A systematic review assessing bidirectionality between sleep disturbances, anxiety, and depression. *Sleep* 2013;36:1059-68. doi: 10.5665/sleep.2810 [published Online First: 2013/07/03]

16. Wilson-Genderson M, Heid AR, Pruchno R. Onset of multiple chronic conditions and depressive symptoms: A life events perspective. *Innovation in Aging* 2017;1:igx022-igx22. doi: 10.1093/geroni/igx022

17. Qian J, Li N, Ren X. Obesity and depressive symptoms among Chinese people aged 45 and over. *Scientific reports* 2017;7:45637. doi: 10.1038/srep45637

18. Zhao Y, Hu Y, Smith JP, et al. Cohort profile: The China Health and Retirement Longitudinal Study (CHARLS). *International journal of epidemiology* 2014;43:61-68. doi: 10.1093/ije/dys203 [published Online First: 2012/12/18]

19. Li C, Liu T, Sun W, et al. Prevalence and risk factors of arthritis in a middle-aged and older Chinese population: The China Health and Retirement Longitudinal Study. *Rheumatology (Oxford, England)* 2015;54:697-706. doi: 10.1093/rheumatology/keu391 [published Online First: 2014/10/08]

20. Andresen EM, Malmgren JA, Carter WB, et al. Screening for depression in well older adults: Evaluation of a short form of the CES-D (Center for Epidemiologic Studies Depression Scale). *American journal of preventive medicine* 1994;10(2):77-84. [published Online First: 1994/03/01]

21. Chen H, Mui AC. Factorial validity of the Center for Epidemiologic Studies Depression Scale short form in older population in China. *International psychogeriatrics / IPA* 2014;26:49-57. doi: 10.1017/s1041610213001701 [published Online First: 2013/10/16]

22. Whelton PK, Carey RM, Aronow WS, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: A report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *Journal of the American College of Cardiology* 2018;71:e127-e248. doi: 10.1016/j.jacc.2017.11.006 [published Online First: 2017/11/18]

23. Zhao Y, Crimmins E, Hu P, et al. China Health And Retirement Longitudinal Study: 2011-2012 national baseline blood data users' guide. Beijing, China: China Center for Economic Research, Peking Universtiy 2014.

24. American Diabetes Association. 2. Classification and diagnosis of diabetes: Standards of medical care in diabetes-2018. *Diabetes care* 2018;41:S13-S27. doi: 10.2337/dc18-S002 [published Online First: 2017/12/10]

25. Machón M, Vergara I, Dorronsoro M, et al. Self-perceived health in functionally independent older people: Associated factors. *BMC geriatrics* 2016;16:66. doi: 10.1186/s12877-016-0239-9 [published Online First: 2016/03/11]

26. Bjelland I, Krokstad S, Mykletun A, et al. Does a higher educational level protect against anxiety and depression? The HUNT study. *Social science & medicine (1982)* 2008;66:1334-45. doi: 10.1016/j.socscimed.2007.12.019 [published Online First: 2008/02/01]

27. Cheng HG, Chen S, McBride O, et al. Prospective relationship of depressive symptoms, drinking, and tobacco smoking among middle-aged and elderly community-dwelling adults: Results from the China Health and Retirement Longitudinal Study (CHARLS).

Journal of affective disorders 2016;195:136-43. doi: 10.1016/j.jad.2016.02.023 [published Online First: 2016/02/20]

28. Zuo M, Gan C, Liu T, et al. Physical predictors of cognitive function in individuals with hypertension: Evidence from the CHARLS basline survey. *Western journal of nursing research* 2018 doi: 10.1177/0193945918770794 [published Online First: 2018/05/11]
29. Sun Y, Shi L, Bao Y, et al. The bidirectional relationship between sleep duration and depression in community-dwelling middle-aged and elderly individuals: Evidence from a longitudinal study. *Sleep medicine* 2018;52:221-29. doi: 10.1016/j.sleep.2018.03.011 [published Online First: 2018/06/05]
30. Li Y, Wu Y, Zhai L, et al. Longitudinal association of sleep duration with depressive symptoms among middle-aged and older Chinese. *Scientific reports* 2017;7:11794. doi: 10.1038/s41598-017-12182-0 [published Online First: 2017/09/20]
31. Nutt D, Wilson S, Paterson L. Sleep disorders as core symptoms of depression. *Dialogues in clinical neuroscience* 2008;10(3):329-36. [published Online First: 2008/11/05]
32. Cole MG, Dendukuri N. Risk factors for depression among elderly community subjects: A systematic review and meta-analysis. *American Journal of Psychiatry* 2003;160:1147-56. doi: 10.1176/appi.ajp.160.6.1147 [published Online First: 2003/06/05]
33. Conti CL, Barbosa WM, Simão JBP, et al. Pesticide exposure, tobacco use, poor self-perceived health and presence of chronic disease are determinants of depressive symptoms among coffee growers from Southeast Brazil. *Psychiatry Res* 2018;260:187-92. doi: 10.1016/j.psychres.2017.11.063 [published Online First: 2017/12/01]

34. Leão T, Perelman J. Depression symptoms as mediators of inequalities in self-reported health: the case of Southern European elderly. *J Public Health (Oxf)* 2018;40(4):756-63. doi: 10.1093/pubmed/fdx173

35. Alarcão V, Madeira T, Peixoto-Plácido C, et al. Gender differences in psychosocial determinants of self-perceived health among Portuguese older adults in nursing homes. *Aging Ment Health* 2018:1-8. doi: 10.1080/13607863.2018.1471583 [published Online First: 2018/05/23]

36. Sonikian M, Metaxaki P, Papavasileiou D, et al. Effects of interleukin-6 on depression risk in dialysis patients. *American journal of nephrology* 2010;31:303-08. doi: 10.1159/000285110 [published Online First: 2010/02/18]

37. Nouwen A, Winkley K, Twisk J, et al. Type 2 diabetes mellitus as a risk factor for the onset of depression: A systematic review and meta-analysis. *Diabetologia* 2010;53:2480-86. doi: 10.1007/s00125-010-1874-x [published Online First: 2010/08/17]

38. Anderson RJ, Freedland KE, Clouse RE, et al. The prevalence of comorbid depression in adults with diabetes: A meta-analysis. *Diabetes care* 2001;24(6):1069-78. [published Online First: 2001/05/26]

39. Palmer S, Vecchio M, Craig JC, et al. Prevalence of depression in chronic kidney disease: Systematic review and meta-analysis of observational studies. *Kidney international* 2013;84:179-91. doi: 10.1038/ki.2013.77 [published Online First: 2013/03/15]

40. Roy T, Lloyd CE. Epidemiology of depression and diabetes: A systematic review. *Journal of affective disorders* 2012;142 Suppl:S8-S21. doi: 10.1016/s0165-0327(12)70004-6 [published Online First: 2012/10/25]

41. Atlantis E, Baker M. Obesity effects on depression: Systematic review of epidemiological studies. *International journal of obesity (2005)* 2008;32:881-91. doi: 10.1038/ijo.2008.54 [published Online First: 2008/04/17]

42. de Wit L, Luppino F, van Straten A, et al. Depression and obesity: A meta-analysis of community-based studies. *Psychiatry research* 2010;178:230-35. doi: 10.1016/j.psychres.2009.04.015 [published Online First: 2010/05/14]

43. Luppino FS, de Wit LM, Bouvy PF, et al. Overweight, obesity, and depression: A systematic review and meta-analysis of longitudinal studies. *Archives of general psychiatry* 2010;67:220-29. doi: 10.1001/archgenpsychiatry.2010.2 [published Online First: 2010/03/03]

44. Lee S, Tsang A, Huang YQ, et al. The epidemiology of depression in metropolitan China. *Psychol Med* 2009;39(5):735-47. doi: 10.1017/S0033291708004091 [published Online First: 2008/08/20]

45. Charlson FJ, Baxter AJ, Cheng HG, et al. The burden of mental, neurological, and substance use disorders in China and India: a systematic analysis of community representative epidemiological studies. *Lancet* 2016 doi: 10.1016/S0140-6736(16)30590-6

46. Wang T, Xiao S, Yang C, et al. Prevalence and incidence of depression disorder and cognitive impairment in the elderly in Shanghai, China. *Alzheimer's & Dementia* 2015;11(7):P832-P33.

47. Li J, Cacchione PZ, Hodgson N, et al. Afternoon napping and cognition in Chinese older adults: Findings from the China Health and Retirement Longitudinal Study Baseline Assessment. *Journal of American Geriatrics Society* 2017;65:373-80. doi: 10.1111/jgs.14368 [published Online First: 2016/12/21]

48. Avasthi A, Grover S. Clinical practice guidelines for management of depression in elderly. *Indian journal of psychiatry* 2018;60:S341-S62. doi: 10.4103/0019-5545.224474 [published Online First: 2018/03/15]

49. Zhang Y, Ting RZ, Yang W, et al. Depression in Chinese patients with type 2 diabetes: Associations with hyperglycemia, hypoglycemia, and poor treatment adherence. *Journal of diabetes* 2015;7:800-8008. doi: 10.1111/1753-0407.12238 [published Online First: 2014/10/29]

50. Fischer MJ, Kimmel PL, Greene T, et al. Elevated depressive affect is associated with adverse cardiovascular outcomes among African Americans with chronic kidney disease. *Kidney international* 2011;80:670-78. doi: 10.1038/ki.2011.153 [published Online First: 2011/06/03]

Tables

Table 1. Baseline characteristics of the CHARLS participants free of depressive symptoms

Variable	Distribution
N	10,288
age, years, mean (SD)	58.5 (9.8)
Male, n (%)	5845 (50.7%)
Living in rural areas, n (%)	8,440 (73.3%)
Education, n (%)	
No formal education or illiterate	2,736 (23.7%)
Some primary school	1,804 (15.7%)
Finished primary school	2,590 (22.5%)
Junior high school or above	4,394 (38.1%)
Currently married, n (%)	10,375 (90.0%)
Smoking status, n (%)	
Current smoker	3,629 (31.5%)
Former smoker	1,034 (9.0%)
Never smoking	6,868 (60.0%)
Drinking status, n (%)	
Regular drinkers	1,951 (17.9%)
Occasional drinkers	476 (4.4%)
Former drinkers	646 (5.9%)
Never drinking	7,833 (71.8%)
Weight, kg, mean (SD)	60 (11.8)
Height, m, mean (SD)	1.6 (0.1)
Body mass index, kg/m^2, mean (SD)	23.7 (4)
Sleeping duration, hours, mean (SD)	6.7 (1.7)
CES-D short form score	5.1 (3.3)
Self-perceived health status, n (%)	
Excellent	483 (4.2%)
Very good	1,744 (15.1%)
Good	4,136 (35.9%)
Fair	3,977 (34.5%)
Poor	1,187 (10.3%)
Chronic conditions, n (%)	
Hypertension	4,045 (40.3%)
Dyslipidemia	1,016 (9.0%)
Diabetes	1,210 (15.0%)
Cancer	97 (0.8%)
Liver disease	387 (3.4%)
Heart disease	1,162 (10.1%)
Stroke	188 (1.6%)
Kidney disease	563 (4.9%)

Gastrointestinal disease	2,180 (18.9%)
Dementia	105 (0.9%)
Arthritis	3,221 (28.0%)
Asthma	312 (2.7%)

Note. CES-D=Center for Epidemiologic Study of Depression short form; SD=standard deviation.

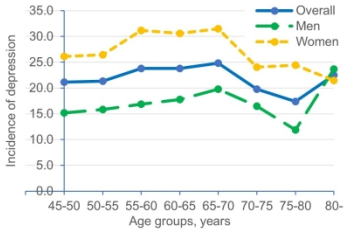
Table 2. Incidence of depressive symptoms among the CHARLS participants

	Ever having depressive Symptoms	Depressive symptoms in both visits 2 & 3	Depressive symptoms in 2 years	Depressive symptoms in 4 years
Overall	22.3 (21.3-23.3)	4.4 (4.0-4.9)	13.2 (12.5-14.1)	16.8 (15.9-17.7)
Rural	25.7 (24.6-26.8)	5.3 (4.8-5.8)	15.3 (14.3-16.2)	18.8 (17.8-19.8)
Urban	15.3 (13.4-17.2)	2.6 (1.9-3.3)	9.0 (7.4-10.6)	12.2 (10.4-14.1)
Men	16.7 (15.5-17.9)	3.0 (2.5-3.5)	9.9 (9.0-10.9)	12.2 (11.1-13.2)
Women	27.9 (26.4-29.4)	5.8 (5.1-6.6)	16.6 (15.3-17.9)	21.5 (20.1-22.9)

Table 3. Raw and multi-variates adjusted associations with the incidence of depressive symptoms in 4 years of follow-up.

	Multi-Variate Adjusted		*Raw Association*	
Variables	OR (95% CI)	P	OR (95% CI)	*P*
Age, per year older	0.99 (0.98-0.99)	**0.001**	0.99 (0.99-1.00)	0.59
Male vs. Female	0.60 (0.51-0.71)	**<.0001**	0.51 (0.46-0.56)	**<.0001**
Education level				
No formal education or illiterate	ref.	**<.0001**	ref.	**<.0001**
Some primary school	1.06 (0.90-1.25)		0.93 (0.80-1.08)	
Finished primary school	0.83 (0.71-0.97)		0.67 (0.57-0.77)	
Junior high school or above	0.71 (0.61-0.84)		0.48 (0.42-0.55)	
Rural vs. Urban	1.61 (1.38-1.88)	**<.0001**	1.72 (1.50-1.96)	**<.0001**
Not married vs Married	1.25 (1.04-1.51)	**0.02**	1.28 (1.08-1.51)	**0.004**
Smoking status				
Non-smokers	ref.		ref.	
Current smokers	1.02 (0.86-1.20)	**0.03**	0.51 (0.41-0.62)	**<.0001**
Former smokers	0.75 (0.59-0.96)		0.68 (0.60-0.76)	
Drinking status				
Never drinkers	Ref.		ref.	
Former drinkers	1.02 (0.80-1.30)	0.15	0.84 (0.67-1.04)	**<.0001**
Occasional drinkers	0.79 (0.59-1.06)		0.59 (0.45-0.78)	
Regular drinkers	0.85 (0.71-1.01)		0.59 (0.51-0.68)	
Body mass index, per 1 kg/m^2 increase	0.99 (0.98-1.01)	0.20	0.99 (0.98-1.00)	0.14
Self-perceived health status				
Excellent	0.36 (0.25-0.52)	**<.0001**	0.28 (0.20-0.39)	**<.0001**
Very good	0.36 (0.29-0.45)		0.28 (0.23-0.35)	
Good	0.53 (0.44-0.63)		0.45 (0.38-0.53)	
Fair	0.61 (0.52-0.73)		0.56 (0.48-0.66)	
Poor	ref.		ref.	
Sleep duration, per hour longer	0.89 (0.87-0.92)	**<.0001**	0.88 (0.85-0.90)	**<.0001**
Hypertension (Y vs. N)	1.07 (0.95-1.21)	0.25	1.07 (0.96-1.18)	0.22
Dyslipidemia (Y vs. N)	0.85 (0.69-1.04)	0.12	0.91 (0.76-1.09)	0.29
Diabetes (Y vs. N)	1.19 (1.00-1.42)	**0.04**	1.11 (0.95-2.30)	0.19
Cancer (Y vs. N)	0.92 (0.48-1.77)	0.80	1.17 (0.65-2.12)	0.61
Chronic Lung Disease (Y vs. N)	1.18 (0.97-1.44)	0.10	1.33 (1.12-1.58)	**0.001**
Chronic Liver Disease (Y vs. N)	0.90 (0.67-1.22)	0.51	1.04 (0.79-1.37)	0.81
Heart Disease (Y vs. N)	1.06 (0.88-1.28)	0.54	1.27 (1.08-1.49)	**0.004**
Stroke (Y vs. N)	0.88 (0.56-1.39)	0.59	1.12 (0.75-1.66)	0.58
Chronic Kidney Disease (Y vs. N)	1.32 (1.04-1.67)	**0.02**	1.45 (1.16-1.80)	**0.001**
Chronic Digestive Disorders (Y vs. N)	1.15 (1.01-1.31)	**0.04**	1.43 (1.26-1.61)	**<.0001**
Psychological Disorders (Y vs. N)	1.00 (0.53-1.89)	0.99	1.44 (0.81-2.56)	0.22
Dementia (Y vs. N)	1.31 (0.72-2.38)	0.37	1.15 (0.67-1.97)	0.62
Arthritis (Y vs. N)	1.43 (1.28-1.61)	**<.0001**	1.72 (1.54-1.91)	**<.0001**
Asthma (Y vs. N)	1.25 (0.90-1.75)	0.19	1.43 (1.06-1.91)	**0.02**

Note. CI=confidence interval; OR=odds ratio



254x190mm (300 x 300 DPI)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort 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	3
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	6-7
Objectives	3	State specific objectives, including any prespecified hypotheses	7
Methods			
Study design	4	Present key elements of study design early in the paper	8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	8-9
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	8
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	9-11
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	9
Bias	9	Describe any efforts to address potential sources of bias	17
Study size	10	Explain how the study size was arrived at	8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	12
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	12
		(*b*) Describe any methods used to examine subgroups and interactions	NA
		(*c*) Explain how missing data were addressed	NA
		(*d*) If applicable, explain how loss to follow-up was addressed	NA
		(*e*) Describe any sensitivity analyses	NA
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	8
		(b) Give reasons for non-participation at each stage	NA
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	13
		(b) Indicate number of participants with missing data for each variable of interest	NA
		(c) Summarise follow-up time (eg, average and total amount)	8
Outcome data	15*	Report numbers of outcome events or summary measures over time	NA
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	11, 13-14
		(*b*) Report category boundaries when continuous variables were categorized	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	14
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	17
Generalisability	21	Discuss the generalisability (external validity) of the study results	17
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	20

*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.

BMJ Open

Incidence and risk factors of depressive symptoms in four years of follow-up among mid-aged and elderly community-dwelling Chinese adults: Findings from the China health and Retirement Longitudinal Study

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2019-029529.R2
Article Type:	Research
Date Submitted by the Author:	21-Jun-2019
Complete List of Authors:	Wen, Yue; West China Hospital, Sichuan University, Department of Gastrointestinal Surgery Liu, Chunjuan; West China Hospital, Sichuan University, Department of Gastrointestinal Surgery Liao, Jing; West China Hospital, Sichuan University, Department of Gastrointestinal Surgery Yin, Yiqiong; West China Hospital, Sichuan University, Department of Gastrointestinal Surgery Wu, Dongmei; University of Electronic Science and Technology of China, The Clinical Hospital of Chengdu Brain Science Institute, MOE Key Lab for Neuroinformation; The Fourth People's Hospital of Chengdu & Chengdu Mental Health Center, Psychiatric Research Laboratory
Primary Subject Heading:	Mental health
Secondary Subject Heading:	Epidemiology
Keywords:	depressive symptoms, incidence, mid-aged and older adults, China

Incidence and risk factors of depressive symptoms in four years of follow-up among mid-aged and elderly community-dwelling Chinese adults: Findings from the China Health and Retirement Longitudinal Study

Yue Wen, Chunjuan Liu, Jing Liao, Yiqiong Yin*, Dongmei Wu*

Correspondence should be made to:

Dongmei Wu, PhD, RN

Department of Nursing, The Clinical Hospital of Chengdu Brain Science Institute, MOE Key Lab for Neuroinformation, University of Electronic Science and Technology of China

Huli West 1st Lane, Chengdu, Sichuan Province, China, 610036.

Tel: 86-28-69515754

E-mail: wudongmei_2001@163.com

Yiqiong Yin, BN, RN

Chief Superintendent Nurse, Department of Gastrointestinal Surgery, West China Hospital, Sichuan University

37 Guoxue Xiang Street, Chengdu, Sichuan Province, China, 610041.

Tel: 86-28-85422877

E-mail: yiqiong489@163.com

*: Yiqiong Yin and Dongmei Wu were co-corresponding authors for this manuscript.

The full names, institutions, city, and country of all other co-authors:

Yue Wen, BN, RN

Supervisor Nurse, Department of Gastrointestinal Surgery, West China Hospital, Sichuan University

37 Guoxue Xiang Street, Chengdu, China, 610041. E-mail: wenyue19820327@163.com

Chunjuan Liu, BN, RN

Supervisor Nurse, Department of Gastrointestinal Surgery, West China Hospital, Sichuan University

37 Guoxue Xiang Street, Chengdu, China, 610041. E-mail: liuchunjuan2002@163.com

Jing Liao, MSN, RN

Senior Nurse, Department of Gastrointestinal Surgery, West China Hospital, Sichuan University

37 Guoxue Xiang Street, Chengdu, China, 610041. E-mail: m15982277765@163.com

Yiqiong Yin, BN, RN

Chief Superintendent Nurse, Department of Gastrointestinal Surgery, West China Hospital, Sichuan University

37 Guoxue Xiang Street, Chengdu, China, 610041. E-mail: yiqiong489@163.com

Dongmei Wu, PhD, RN

Assistant Professor, Department of Nursing, The Clinical Hospital of Chengdu Brain Science Institute, MOE Key Lab for Neuroinformation, University of Electronic Science and Technology of China

Huli West 1st Lane, Chengdu, China, 610036. Tel: 86-28-69515754. E-mail: wudongmei_2001@163.com

Word count: 7467

Abstract

Objectives. The purpose of this study was to examine the incidence of depressive symptoms, and determine if baseline risk factors conferred a risk for incident depressive symptoms over time in a nationally representative sample of mid-aged and elderly Chinese population.

Design. This study was a secondary analysis of a prospective cohort from a nationally representative sample.

Setting. Community samples in 28 provinces of China were recruited from the baseline survey of the China Health and Retirement Longitudinal Study. A four-stage, stratified, cluster probability sampling strategy was used, which included 10,257 households with members aged 45 years or older and their spouse.

Participants. A total of 11,533 participants free of depressive symptoms at baseline were identified, and 10,288 were re-examined in either the first and/or the second follow-up surveys. The current analyses were conducted among the 10,288 participants.

Primary and secondary outcome measures. Depressive symptoms were measured by the Center for Epidemiological Studies Depression Scale short form.

Results. The findings showed that the incidence of depressive symptoms in a 4-year follow-up was as high as 22.3%. The incidence was higher in rural areas and women. Furthermore, longer sleeping duration and better self-perceived health status were both associated with lower risk of depressive symptoms. On contrary, having diabetes and chronic kidney disease at baseline increased the risk of depressive symptoms. However, baseline body mass index was not associated with the onset of depressive symptoms in this population.

Conclusions. The findings of this study highlight the importance of developing an appropriate screening test to identify depressive symptoms for those who are vulnerable and ensure these individuals can receive early interventions for depressive symptoms.

Key words: depressive symptoms, incidence, mid-aged and older adults, China

Strengths and limitations of this study

- Since the sample was representative of community-dwelling mid-aged and older Chinese adults, the study results can be generalized to mid-aged and older Chinese adults.
- This is the first study in China to estimate the incidence of depressive symptoms in a nationally representative population in China.
- Depressive symptoms were based on self-reports instead of clinically diagnosis. Therefore, information bias may be present. However, with longitudinal design, information bias in the current study was very likely to be non-differential.
- This study was a prospective analysis of baseline risk factors with depressive symptoms at follow-up, and no causal associations between these predictors and depressive symptoms can be drawn from the analysis.

Introduction

Depression has been recognized as a leading cause of disability and a major contributor to disease burdens globally [1]. An estimated 322 million adults had depression in 2015 worldwide, with nearly half of these people living in the South-East Asia and Western Pacific regions [2]. In China, about 4.2% adult population was estimated to be depressed, and the prevalence of depression reached a peak in older adulthood [2]. With fast economic growth, mid-aged adults are exposed to a high-stress lifestyle, which is thought to contribute significantly to an increase in mental health disorders in susceptible people [1]. Older adults, on the other hand, face noteworthy challenges to their life, including loss of independence, loss of social support due to the death of a spouse or weakened family connectedness (traditionally referred to as 'filial piety'), financial difficulties, and medical vulnerability [3]. Late-life depressive symptoms increase risk for significant impairment in social function [3], dementia [4], declined quality of life [5], and suicide [6]. They further complicate the prognosis of concurrent medical problems by increasing physical disability and decreasing motivation and adherence to prescribed medications and/or exercise or rehabilitation programs [7 8].

Although depression has come to be regarded as the common cold of psychosocial functioning in Western culture, mental disorders are still viewed as degrading not only to the patient, but also to the entire family in Chinese culture [9 10]. In addition, although effective interventions have been developed to alleviate symptoms of depression, depressive symptoms are often overlooked among the elderly, since most of them mistakenly consider these symptoms to be part of the normal ageing process [11]. Therefore, older adults may not actively seek medical treatment and leave their depressive symptoms undiagnosed or untreated. As persons aged 45 or older will increase from 32% to 51% of the total population from 2010 to 2040 in China [12],

reliable and up-to-date estimates of the proportion of this population affected by depressive symptoms are a key ingredient of effective health policy, planning, and evaluation.

Recently, a number of population-based studies have estimated prevalence of depressive symptoms among mid-aged and older Chinese adults [3 11 13 14]. Given that all these studies were cross-sectional, the incidence of depressive symptoms among mid-aged and older Chinese adults was not clear. Furthermore, despite a myriad of studies that examined a number of health conditions associated with an increased risk of mid- and late-life depressive symptoms, including chronic diseases, overweight/obesity, sleep duration, and self-perceived health status [3 14-17], the prospective relationships between these health conditions and depressive symptoms have not been well understood in this population. Such prospective relationships may provide further evidence on how baseline conditions may be predictive of depressive symptoms in the follow-up than cross-sectional analysis, especially given that these health conditions are expected to be a great challenge to an increasing aging population, and can often co-occur with depressive symptoms which may make these conditions worse [3]. A better understanding of these associations may also provide information that is useful in identifying patients who are vulnerable to mid-life or late-life depressive symptoms, and proactively assessing and treating modifiable risk factors during primary health care service.

Therefore, the purpose of this study was to examine the incidence of depressive symptoms among mid-aged and older adults in China, and determine if baseline sleep duration, body weight, self-perceived health status, and chronic conditions conferred a risk for incident depressive symptoms over time, using baseline and four years of follow-up data from the China Health and Retirement Longitudinal Study (CHARLS).

Methods

Study Design

This study was a secondary analysis of prospective data from the CHARLS. The CHARLS is a nationwide, community-engaged, population-based epidemiological study of Chinese adults aged 45 years or older. The purpose of the CHARLS was to obtain detailed information regarding the dynamics of retirement and how it interacts with health, health insurance, and economic well-being. The CHARLS collects detailed information on a wide range of domains, including demographics, health status, physical measures, employment history, pension insurance, retirement, income, expenditures and assets [18]. The current study used data from baseline, the first, and the second follow-up surveys.

Participants

The CHARLS national baseline survey was conducted in 28 provinces (Tibet, Ningxia, and Hainan were not included) across the country from May 2011 to March 2012. It was a survey of 10,257 households with members aged 45 years or older and their spouse, for a total of about 17,708 individuals. A four-stage, stratified, cluster probability sampling strategy was used to select eligible participants [18]. Details of the sampling procedure are published elsewhere [19]. In brief, in the first stage, all counties were grouped by gross domestic product and by urban or rural regions. In the second stage, counties were stratified and sampled using probabilities proportional to size (PPS). Three rural villages and urban neighborhoods were randomly selected as primary sampling units (PSUs) using PPS in each county. In the third stage, all buildings in each PSU were recognized on Google Earth. A sample of 24 households was randomly selected among all households in each PSU. In the final stage, a short screening form was employed to ensure study eligibility in selected households and members of 45 years of age or above were

invited to enroll into the study. The response rate for the survey was over 80% (94% in rural areas and 69% in urban areas) [18].

The baseline cohort of the CHARLS participants was followed up every two years with the same survey questionnaires and biomedical measures [18]. The first follow-up survey of the CHARLS was fielded between July 2013 and January 2014. Subjects in this study used the same inclusion and exclusion criteria as the original study. A total of 11,533 participants free of depressive symptoms at baseline were identified, of whom 9,329 participated in the first follow-up survey in 2013-2014, 9,157 were examined in the second follow-up survey in 2015-2016, and 10,288 were followed in either the first or the second follow-up surveys. The current analyses were conducted among the 10,288 participants.

Patient and Public Involvement

Participants with abnormal findings, including depressive symptoms were suggested to visit a physician for further clinical evaluation. In the current study, we used de-identified data from the CHARLS with no direct involvement of or interaction with participants in the design, recruitment or conduct of the original cohort study.

Variables, Definitions, and Measures

Depressive symptoms. The Center for Epidemiological Studies Depression Scale (CES-D) short form was used to measure depressive symptoms [20]. The CES-D short form consists of ten items, and each item was rated on a four-point Likert scale with answers ranging from 0 (rarely or none of the time) to 3 (most or all of the time) with the total possible summary score of 0 to 30. The time frame for the CES-D short form refers to the week prior to interview. Item 5 ("feeling hopeful about the future") and 8 ("feeling happy") were reversely scored before

analysis. Higher scores corresponds to higher levels of depressive symptoms, and a score of 12 or higher has been used as the cut-off point for depressive symptoms [21].

The CES-D short form has been validated among a subsample of 742 CHARLS participants aged 60 years and older, showing adequate psychometric properties [21]. Confirmatory factor analysis showed that the two-factor model had the best fit. Depressive affect and somatic retardation were loaded as the first factor, and positive affect was loaded as the second factor. The two-factor structure varied across both genders in multi-group analysis (χ^2= 144.13, $p<0.001$). R^2 coefficient was used to measure the reliability of each item, and some of them differed between both gender groups. For example, depressive affect and somatic retardation accounted for 37% and 64% of the variance in the depression indicator ("bothered") for the males and females, respectively [21].

Measure of health conditions associated with depressive symptoms. These factors included chronic conditions, overweight/obesity, sleep duration, and self-perceived health status. Information on chronic conditions was primarily based on self-reports except hypertension and diabetes. Participants were asked if they had been diagnosed with any of the following health conditions: arthritis, dyslipidemia, cancer (excluding minor skin cancers), liver diseases (except for fatty liver, tumors or cancer), cardiovascular diseases (heart attack, coronary heart disease, angina, congestive heart failure, or other heart problems), stoke, kidney disease (except for cancer or tumor), stomach or other gastrointestinal diseases (except for tumor or cancer), memory-related diseases, and asthma. Participants answered "yes" to these questions were defined as having these doctor-diagnosed conditions.

Hypertension was defined based on the most current guidelines from the American Heart Association, which have lowered the threshold of hypertension cut-off points to 130/80 mmHg [22].

A systolic blood pressure measurement of 130 mmHg and higher, or a diastolic measurement of 80 mmHg and higher, or 130/80 mmHg and higher, or taking antihypertensive medications including modern western medicine, traditional Chinese medicine, or using other treatment for hypertension was considered as having hypertension [22]. Blood pressure was measured three times (approximately 45 seconds apart) for each participant on the left arm in sitting position, using an electronic blood pressure monitor (Omron™ HEM-7112)[23].

The diagnosis of diabetes was based on the current guidelines from the American Diabetes Association (2018). Readings of 126 mg/dL or higher for fasting blood glucose ≥126 mg/dL, or readings of 200 mg/dL or higher for random blood glucose, or readings of 6.5% or higher for glycated hemoglobin, or use of insulin, or taking oral hypoglycemic medications including traditional Chinese medicine, modern western medicine, or other diabetes treatment was considered as having diabetes [24].

Weight was measured to the nearest 0.1 kg using a digital scale (Omron™ HN-286, Yangzhou, China) on an even, uncarpeted surface, with participants removing heavy outer clothing. Height was measured without shoes to the nearest 0.1 cm using a stadiometer (Seca™213, Hangzhou, China). Body mass index (BMI, weight in kilograms divided by height in meters squared) was calculated from the participants' weight and height.

Self-perceived health status is a powerful indicator of the health status of elderly people [25]. It was measured based on self-reports to the following question, “Would you rate health as…”,with five response options provided: excellent, very good, good, fair, and poor.

Sleep duration in hours was collected using a question, “During the past month, how many hours of actual sleep did you get at night (average hours for one night)? (This may be shorter than the number of hours you spend in bed.)”

Covariates. Factors that could confound the main association were identified a priori from current literature. Covariates included age, gender [3], education [26], and marital status [3 27]. Consistent with a prior CHARLS publication [28], education was categorized as illiterate or no formal education, some primary school but can read and write, primary school including home schooling, and middle school or above. Marital status was grouped as married versus not married.

Ethical Considerations

The CHARLS was approved by the Ethical Review Committee. The current study is a secondary analysis of the de-identified CHARLS public data. The Ethics Review Committee granted the current study exemption from review.

Statistical Analysis

Incidence of depressive symptoms. The incidence of depressive symptoms was analyzed taking into account the complex survey design and nonresponse rate in both estimates and the corresponding standard errors (SEs). Participants were categorized into 5-year age groups. SAS PROC SURVEYFREQ procedure was used to obtain the overall and gender specific incidence of depressive symptoms among all participants and by the 5-year age groups. In addition, overall and gender-specific incidence of depressive symptoms was estimated by rural and urban areas. We estimated the incidence of four outcomes of depressive symptoms: having depressive symptoms in the first follow-up survey (2013-2014); having depressive symptoms in the second follow-up survey (2015-2016); ever having depressive symptoms in the first or the second follow-up survey; and consistently having depressive symptoms in both follow-up surveys.

Prospective analysis. Baseline characteristics of the participants were summarized as frequency and percentage for categorical variables and mean and standard deviation or median

and interquartile range for continuous variables. Associations of baseline health behaviors, including chronic conditions, overweight/obesity, sleep duration, and self-perceived health status, with the incidence of ever having depressive symptoms in 4 years of follow-up were evaluated by a multivariate logistic regression model, while controlling for all covariates as mentioned above. Odds ratios (ORs) and the corresponding 95% confidence intervals (CIs) were reported. The SAS 9.4 (SAS Institute Inc., Cary, North Carolina) was used to perform the analyses. All the p values were two-sided, and $p<0.05$ was considered significant.

Results

Sample Characteristics

A total of 10,288 participants aged 45 years or older were included in the estimate of depressive symptoms incidence. As shown in Table 1, the average age of all participants was 58.5 years and roughly half participants (49.3%) were women. Most of the participants (73.3%) lived in rural areas and 60.6% participants had education of primary school or above. The majority of participants (90.0%) were married or living with a partner at the time of data collection. About a third of the participants (31.5%) were current smokers and 17.9% were current regular drinkers. Participants had an average BMI of 23.7 kg/m^2. The mean duration of sleep per night was 6.7 hours, and less than 20% of participants perceived their health as very good or excellent. The mean CES-D short form score was 5.1 at baseline.

Incidence of Depressive Symptoms

As shown in Table 2 and in Figure 1, the incidence of ever having depressive symptoms in 4 years was 22.3% (95% CI: 21.3%-23.3%). The incidence was much higher in rural areas than that in urban areas (25.7% vs. 15.3%, $p<0.0001$). Women had higher incidence of depressive symptoms than men (27.9% vs. 16.7%, $p<0.0001$). There is no clear pattern of the

incidence of depressive symptoms over age groups (Figure 1). The incidence was highest among the 65-70 years of age group and lowest among the 45-50 years of age group.

Baseline Risk Factors and Incident Depressive Symptoms

As shown in Table 3, in the fully adjusted multivariable logistic regression model, sleeping duration and self-perceived health status were both inversely associated with the risk of depressive symptoms. Specifically, participants with an hour longer of sleeping had a 10% (95% CI: 7%-13%, p<0.0001) lower risk of developing depressive symptoms in 4 years of follow up. Compared to individuals who perceived their health status as poor, those who perceived their health status as fair, good, very good, and excellent had 42% (95% CI: 39%-52%), 47% (95% CI: 36%-57%), 64% (95% CI: 54%-72%), and 62% (95% CI: 43%-74%) lower risk of developing depressive symptoms, respectively. In addition, three chronic conditions, diabetes (OR=1.19, 95% CI: 1.00-1.42, p=0.04), chronic kidney disease (OR=1.37, 95% CI: 1.05-1.79, p=0.02), chronic digestive disorders (OR=1.15, 95% CI: 1.01-1.31, p=0.04), and arthritis (OR=1.43, 95% CI: 1.28-1.61, p<0.0001) were associated with higher risk of depressive symptoms. However, baseline BMI was not associated with the onset of depressive symptoms in this population (OR=0.99, 95% CI: 0.97-1.01). Chronic lung disease (p=0.001), chronic liver disease (p=0.004), and asthma (p=0.02) were positively associated with incidence of depressive disorder in the raw analysis, but became non-significant in the fully adjusted model (all p>0.05).

Discussion

Through analysis to data of a nationally representative sample of mid-aged and older Chinese adults, we found that the incidence of depressive symptoms in a 4-year follow-up was as high as 22.3%. Large disparities in the incidence of depressive symptoms were observed between rural and urban areas and between men and women. Furthermore, longer sleeping

duration and better self-perceived health status were both associated with lower risk of depressive symptoms. On contrary, having diabetes and chronic kidney disease at baseline increased the risk of depressive symptoms. However, baseline BMI was not associated with depressive symptoms in this population.

This is the first study that examined the incidence of depressive symptoms in a nationally representative population in China. Our study found that in 4 years of follow-up, as high as 22.3% of the mid-aged and older Chinese adults developed depressive symptoms. Using the same database, a recent study reported that the prevalence of depressive symptoms at CHARLS baseline survey was up to 26.2% [13]. Collectively, these findings revealed that depressive symptoms were a major public health challenge in China, and intervention programs should be developed to reduce the burden of depressive symptoms. Furthermore, large disparities were also observed between rural and urban residents and between men and women. In particular, women and residents living in rural areas were at a higher risk of developing depressive symptoms. The high incidence rate is not only relevant to middle-aged and older Chinese adults, it also has implications for younger generations of the Chinese. Many depressive symptoms cases remained undiagnosed, and even among those who were aware of the condition, very few sought treatments due to cultural stigma [9 10] . Middle-aged and elderly grandparents are the primary caregivers of infants, toddlers, and young children in rural China. Depressed caregivers were more likely to show negative parenting interactions (e.g., limited facial and behavioral affect) with their children, and these interactions were directly relevant for children's development [29 30]. A strong negative correlation has been reported between the levels of depression of grandmothers and the levels of developmental outcomes of the grandchildren in their care, including cognitive, language, social-emotional, and motor functions [31 32]. Taken together,

changes in social policies and intervention programs should be developed to address timely diagnosis and treatment of depression for these people, which will help improve young children's developmental outcomes in rural China.

Individuals with longer sleep duration had lower risk of depressive symptoms. This finding is in line with previous studies [33 34]. Sleep disorders are often the presenting and core symptoms of depression [35]. However, treatment of depression did not resolve sleep symptoms, which may confer a greater risk for depression recurrence and relapse [35]. Therefore, sleep deprivation should be at least considered as an early indicator of depressive symptoms. Individuals with sleep deprivation should be aware of their high risk of depressive symptoms and manage to improve the length of their sleeping.

Better self-perceived health status also reduced the risk of depressive symptoms in the current study. The finding is consistent with studies among other populations [36 37]. Self-perceived health is a powerful indicator of the overall health status of elderly people [25]. Many factors, including sociodemographic characteristics, chronic disease, functional status, social relationships, neighborhood environment, and nutrition pattern, were all important determinants of self-perceived health [25]. These factors are also associated with depressive symptoms. The current study adjusted most of the factors, except for functional status, social relationship, and nutrition pattern, which were not available in the CHARLS database. However, poorer self-perceived health status was still significantly associated with higher risk of depressive symptoms. Future studies additionally controlling for those factors will help to evaluate the contribution of those factors on the associations of self-perceived health status with depressive symptoms. Furthermore, such study may also help delineate whether self-perceived health status may represent other factors that may lead to depressive symptoms. Finally, individuals with

depressive disorders were more likely to report poor self-perceived health [38 39]. Therefore, there might be a bidirectional association between depressive symptoms and self-perceived health. Future studies examining the bi-directional relationship are warranted.

Among 12 chronic conditions, baseline chronic kidney disease increased the risk of depressive symptoms at follow-up. Although the underlying mechanisms have not been well understood, some authors suggested that the psychosocial and biologic changes in dialysis may explain this relationship [40]. In addition to chronic kidney disease, baseline diabetes also conferred a higher risk of symptoms of depression over time in this study. Similar results were reported in a meta-analysis of 11 studies, which found that people with diabetes at baseline had a 24% higher risk of developing depression at follow-up compared to those without diabetes [41]. In addition, high prevalence of depression among people with diabetes and/or chronic kidney disease has also been observed in cross-sectional studies [42-44]. In concordance with these findings, this study added further evidence that compared to other chronic conditions at baseline, baseline chronic disease and diabetes were more likely to be associated with depressive symptoms over time in a population of mid-aged and older Chinese population.

Overweight/obesity is well established to interfere with mental health, with depressive symptoms being more common among overweight/obese individuals than their normal-weight counterparts, especially in overweight/obese women [45 46]. A meta-analysis of longitudinal studies further confirmed this relationship, in which excess weight at baseline increased a higher risk for incident depression at follow-up [47]. In contrast to these findings from Western and European countries, using data from a prospective survey of a large, representative sample of mid-aged and elderly community-dwelling residents in Mainland China, we did not find a relationship between baseline BMI and subsequent depressive symptoms over time. These inconsistent findings may

suggest that because participants in the current study were predominantly low in BMI at baseline (mean BMI was 23.7 kg/m^2), their likelihood of experiencing depressive symptoms may have been lower compared to those participants reported in Luppino et al [47]. However, these are preliminary findings that need to be further investigated in future prospective studies in this population.

The study has several important strengths. First, to the best of our knowledge, this is the first study to estimate incidence of depressive symptoms in a nationally representative sample of middle-aged and older Chinese adults. Previous studies have focused on the estimation of depressive symptoms prevalence [48 49] or investigated the incidence of depressive symptoms in a regional sample [50]. Second, since the sample was representative of community-dwelling mid-aged and older Chinese adults, the results can be generalized to mid-aged and older Chinese adults. Third, a Chinese specific cut-off point of the CES-D short form score for depressive symptoms has been used, and the cut-off point was validated among middle-aged and older Chinese adults [21]. Therefore, our study provided more reliable estimate of the incidence of depressive symptoms. Finally, strict quality control measures, including GPS matching, data checking, recording and checking interviews, and calling back participants, were implemented at each stage of the study to ensure data quality and reliability.

There were also some limitations in this study that should be acknowledged. First, depressive symptoms were based on self-reports instead of clinically diagnosis. Therefore, information bias may be present. However, with longitudinal design, information bias in the current study was very likely to be non-differential. Since non-differential misclassification generally bias the association estimates towards the null, our study findings were more robust. Second, nighttime sleep duration was also measured based on self-reports. The use of self-

reported measures in the CHARLS surveys may have biased study results, since participants may consistently under- or overestimate their nighttime sleep duration [51]. Objective or direct measures of sleep duration should be used to increase precision and accuracy of self-report assessment. Finally, this study was a prospective analysis of baseline risk factors with depressive symptoms at follow-up, and no causal associations between these predictors and depressive symptoms can be drawn from the analysis.

The findings of the current study have important implications for clinical practice. Health care professionals are especially encouraged to address the needs for better mental health in elderly population [52]. In view of the high incidence of depressive symptoms (22.3%) among mid-aged and elderly Chinese, the findings of this study highlight the importance of developing an appropriate screening test to identify depressive symptoms for those who are vulnerable and ensure these individuals can receive early interventions for depressive symptoms. The screening test should include items such as areas of living (rural or urban areas), gender, age groups, nighttime sleep duration, self-perceived health status, and certain chronic conditions, especially chronic kidney disease and diabetes. In addition, intervention strategies that address short nighttime sleep duration may be used to alleviate depressive symptoms and improve mental health in this population. Intervention programs should also be prioritized to target at specific populations, such as women and residents living in rural areas, as these populations were at a higher risk of developing depressive symptoms. Finally, new patients with chronic kidney disease and diabetes should be screened for depression using the CES-D short form at initial visit. Persons with depressive symptoms (a score of 12 or higher) should then be assessed by a clinician using the structured clinical interview for Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition. Potential participants with serious depressive symptoms should be

referred immediately to a mental health professional. Individuals with these two conditions are particularly vulnerable to the deleterious effects of affective symptoms, since symptoms of depression is a known risk factor for noncompliance with medical treatment and adverse health outcomes [53 54].

Conclusions

To conclude, our study found a high incidence of depressive symptoms in 4 years of follow-up among a nationally representative mid-aged and older Chinese population. In addition, great disparities in the incidence of depressive symptoms were observed between individuals lived in rural and urban areas and between men and women. Furthermore, we identified that worse self-perceived health, shorter duration of sleeping, diabetes and chronic kidney disease at baseline increased the risk for depressive symptoms. These findings supported the importance of baseline status to longitudinal changes in depressive symptoms. Thus, interventions for vulnerable mid-aged and older adults should focus on addressing short nighttime sleep duration. These findings also help identify individuals at higher risk for depressive symptoms, such as those with chronic kidney disease and diabetes, or women and residents living in rural areas, so that early interventions can be implemented to prevent depressive symptoms.

Figure Legend

Figure 1. The Incidence of Depressive Symptoms in 4 Years of Follow-up among Participants of the CHARLS

Contributorship Statement

All authors contribute to the conception and design of this study. YW, YY, and DW were responsible for the design, analysis, drafting and revision of this manuscript. CL and JL were responsible for interpretation of data and preparation of the manuscript.

Competing Interests Statement

None declared.

Funding Statement

This work was supported by the Sichuan Science and Technology Program grant number 2018JY0306 to Dr. Dongmei Wu. The CHARLS is funded by Peking University, the National Natural Science Foundation of China, the Behavioral and Social Research Division of the National Institute on Aging, and the World Bank.

Acknowledgments

The authors would gratefully acknowledge the assistance Dr. Tingting Liu, an assistant professor at University of Arkansas Eleanor Mann School of Nursing for editing the manuscript.

Patient Consent for Publication

Not required.

Data Sharing Statement

The study used a public data from the CHARLS that were obtained from the CHARLS home page at http://charls.pku.edu.cn/en.

References

1. Qin X, Wang S, Hsieh C. The prevalence of depression and depressive symptoms among adults in China: Estimation based on a National Household Survey. *China Economic Review* 2016 doi: 10.1016/j.chieco.2016.04.001

2. World Health Organization. Depression and other common mental disorders: Global health estimates. Geneva, Swiss: World Health Organization 2017.

3. Lei X, Sun X, Strauss J, et al. Depressive symptoms and SES among the mid-aged and elderly in China: Evidence from the China Health and Retirement Longitudinal Study national baseline. *Social Science & Medicine* 2014;120:224-32. doi: 10.1016/j.socscimed.2014.09.028 [published Online First: 2014/09/28]

4. Diniz BS, Butters MA, Albert SM, et al. Late-life depression and risk of vascular dementia and Alzheimer's disease: Systematic review and meta-analysis of community-based cohort studies. *The British journal of psychiatry : the journal of mental science* 2013;202:329-35. doi: 10.1192/bjp.bp.112.118307 [published Online First: 2013/05/03]

5. Sivertsen H, Bjørkløf GH, Engedal K, et al. Depression and quality of life in older persons: A review. *Dementia and geriatric cognitive disorders* 2015;40:311-39. doi: 10.1159/000437299

6. Wang CW, Chan CL, Yip PS. Suicide rates in China from 2002 to 2011: An update. *Social psychiatry and psychiatric epidemiology* 2014;49:929-41. doi: 10.1007/s00127-013-0789-5 [published Online First: 2013/11/19]

7. Holzapfel N, Lowe B, Wild B, et al. Self-care and depression in patients with chronic heart failure. *Heart & Lung* 2009;38:392-97. doi: 10.1016/j.hrtlng.2008.11.001 [published Online First: 2009/09/17]

8. Gonzalez JS, Safren SA, Delahanty LM, et al. Symptoms of depression prospectively predict poorer self-care in patients with type 2 diabetes. *Diabetetic Medicine* 2008;25:1102-07. doi: 10.1111/j.1464-5491.2008.02535.x [published Online First: 2009/02/03]

9. Zeng B, Sun W, Gary RA, et al. Towards a conceptual model of diabetes self-management among Chinese immigrants in the United States. *International journal of environmental research and public health* 2014;11:6727-42. doi: 10.3390/ijerph110706727 [published Online First: 2014/07/01]

10. He P, Hu Y, Li C, et al. Predictors of depressive symptoms among mid-aged and older men with diabetes in China. *Research and theory for nursing practice* 2019;33(1):6-22. doi: 10.1891/1541-6577.33.1.6 [published Online First: 2019/02/24]

11. Xu Y, Yang J, Gao J, et al. Decomposing socioeconomic inequalities in depressive symptoms among the elderly in China. *BMC public health* 2016;16:1214. doi: 10.1186/s12889-016-3876-1 [published Online First: 2016/12/03]

12. United Nations Deparment of Economic and Social Affais/Population Division. World population prospects: The 2012 revision, volume II: Demophic profiles. New York, NY: United Nations 2012.

13. Li C, Miles T, Shen L, et al. Early-life exposure to severe famine and subsequent risk of depressive symptoms in late adulthood: The China Health and Retirement Longitudinal Study. *British Journal of Psychiatry* 2018;213:579-86. doi: 10.1192/bjp.2018.116 [published Online First: 2018/08/31]

14. Yu J, Li J, Cuijpers P, et al. Prevalence and correlates of depressive symptoms in Chinese older adults: A population-based study. *International journal of geriatric psychiatry* 2012;27:305-12. doi: 10.1002/gps.2721 [published Online First: 2011/05/04]

15. Alvaro PK, Roberts RM, Harris JK. A systematic review assessing bidirectionality between sleep disturbances, anxiety, and depression. *Sleep* 2013;36:1059-68. doi: 10.5665/sleep.2810 [published Online First: 2013/07/03]

16. Wilson-Genderson M, Heid AR, Pruchno R. Onset of multiple chronic conditions and depressive symptoms: A life events perspective. *Innovation in Aging* 2017;1:igx022-igx22. doi: 10.1093/geroni/igx022

17. Qian J, Li N, Ren X. Obesity and depressive symptoms among Chinese people aged 45 and over. *Scientific reports* 2017;7:45637. doi: 10.1038/srep45637

18. Zhao Y, Hu Y, Smith JP, et al. Cohort profile: The China Health and Retirement Longitudinal Study (CHARLS). *International journal of epidemiology* 2014;43:61-68. doi: 10.1093/ije/dys203 [published Online First: 2012/12/18]

19. Li C, Liu T, Sun W, et al. Prevalence and risk factors of arthritis in a middle-aged and older Chinese population: The China Health and Retirement Longitudinal Study. *Rheumatology (Oxford, England)* 2015;54:697-706. doi: 10.1093/rheumatology/keu391 [published Online First: 2014/10/08]

20. Andresen EM, Malmgren JA, Carter WB, et al. Screening for depression in well older adults: Evaluation of a short form of the CES-D (Center for Epidemiologic Studies Depression Scale). *American journal of preventive medicine* 1994;10(2):77-84. [published Online First: 1994/03/01]

21. Chen H, Mui AC. Factorial validity of the Center for Epidemiologic Studies Depression Scale short form in older population in China. *International psychogeriatrics / IPA* 2014;26:49-57. doi: 10.1017/s1041610213001701 [published Online First: 2013/10/16]

22. Whelton PK, Carey RM, Aronow WS, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: A report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *Journal of the American College of Cardiology* 2018;71:e127-e248. doi: 10.1016/j.jacc.2017.11.006 [published Online First: 2017/11/18]

23. Zhao Y, Crimmins E, Hu P, et al. China Health And Retirement Longitudinal Study: 2011-2012 national baseline blood data users' guide. Beijing, China: China Center for Economic Research, Peking Universtiy 2014.

24. American Diabetes Association. 2. Classification and diagnosis of diabetes: Standards of medical care in diabetes-2018. *Diabetes care* 2018;41:S13-S27. doi: 10.2337/dc18-S002 [published Online First: 2017/12/10]

25. Machón M, Vergara I, Dorronsoro M, et al. Self-perceived health in functionally independent older people: Associated factors. *BMC geriatrics* 2016;16:66. doi: 10.1186/s12877-016-0239-9 [published Online First: 2016/03/11]

26. Bjelland I, Krokstad S, Mykletun A, et al. Does a higher educational level protect against anxiety and depression? The HUNT study. *Social science & medicine (1982)* 2008;66:1334-45. doi: 10.1016/j.socscimed.2007.12.019 [published Online First: 2008/02/01]

27. Cheng HG, Chen S, McBride O, et al. Prospective relationship of depressive symptoms, drinking, and tobacco smoking among middle-aged and elderly community-dwelling adults: Results from the China Health and Retirement Longitudinal Study (CHARLS).

Journal of affective disorders 2016;195:136-43. doi: 10.1016/j.jad.2016.02.023 [published Online First: 2016/02/20]

28. Zuo M, Gan C, Liu T, et al. Physical predictors of cognitive function in individuals with hypertension: Evidence from the CHARLS basline survey. *Western journal of nursing research* 2018 doi: 10.1177/0193945918770794 [published Online First: 2018/05/11]
29. Lovejoy MC, Graczyk PA, O'Hare E, et al. Maternal depression and parenting behavior: A meta-analytic review. *Clinical psychology review* 2000;20(5):561-92. [published Online First: 2000/06/22]
30. Pelaez M, Field T, Pickens JN, et al. Disengaged and authoritarian parenting behavior of depressed mothers with their toddlers. *Infant behavior & development* 2008;31(1):145-8. doi: 10.1016/j.infbeh.2007.06.002 [published Online First: 2007/07/27]
31. Yue A, Gao J, Yang M, et al. Caregiver depression and early child development: A mixed-methods study from rural China. *Frontiers in psychology* 2018;9:2500. doi: 10.3389/fpsyg.2018.02500 [published Online First: 2019/01/09]
32. Zhang S, Dang R, Yang N, et al. Effect of caregiver's mental health on early childhood development across different rural communities in China. *International journal of environmental research and public health* 2018;15(11) doi: 10.3390/ijerph15112341 [published Online First: 2018/10/27]
33. Sun Y, Shi L, Bao Y, et al. The bidirectional relationship between sleep duration and depression in community-dwelling middle-aged and elderly individuals: Evidence from a longitudinal study. *Sleep medicine* 2018;52:221-29. doi: 10.1016/j.sleep.2018.03.011 [published Online First: 2018/06/05]

34. Li Y, Wu Y, Zhai L, et al. Longitudinal association of sleep duration with depressive symptoms among middle-aged and older Chinese. *Scientific reports* 2017;7:11794. doi: 10.1038/s41598-017-12182-0 [published Online First: 2017/09/20]

35. Nutt D, Wilson S, Paterson L. Sleep disorders as core symptoms of depression. *Dialogues in clinical neuroscience* 2008;10(3):329-36. [published Online First: 2008/11/05]

36. Cole MG, Dendukuri N. Risk factors for depression among elderly community subjects: A systematic review and meta-analysis. *American Journal of Psychiatry* 2003;160:1147-56. doi: 10.1176/appi.ajp.160.6.1147 [published Online First: 2003/06/05]

37. Conti CL, Barbosa WM, Simão JBP, et al. Pesticide exposure, tobacco use, poor self-perceived health and presence of chronic disease are determinants of depressive symptoms among coffee growers from Southeast Brazil. *Psychiatry Res* 2018;260:187-92. doi: 10.1016/j.psychres.2017.11.063 [published Online First: 2017/12/01]

38. Leão T, Perelman J. Depression symptoms as mediators of inequalities in self-reported health: the case of Southern European elderly. *J Public Health (Oxf)* 2018;40(4):756-63. doi: 10.1093/pubmed/fdx173

39. Alarcão V, Madeira T, Peixoto-Plácido C, et al. Gender differences in psychosocial determinants of self-perceived health among Portuguese older adults in nursing homes. *Aging Ment Health* 2018:1-8. doi: 10.1080/13607863.2018.1471583 [published Online First: 2018/05/23]

40. Sonikian M, Metaxaki P, Papavasileiou D, et al. Effects of interleukin-6 on depression risk in dialysis patients. *American journal of nephrology* 2010;31:303-08. doi: 10.1159/000285110 [published Online First: 2010/02/18]

41. Nouwen A, Winkley K, Twisk J, et al. Type 2 diabetes mellitus as a risk factor for the onset of depression: A systematic review and meta-analysis. *Diabetologia* 2010;53:2480-86. doi: 10.1007/s00125-010-1874-x [published Online First: 2010/08/17]

42. Anderson RJ, Freedland KE, Clouse RE, et al. The prevalence of comorbid depression in adults with diabetes: A meta-analysis. *Diabetes care* 2001;24(6):1069-78. [published Online First: 2001/05/26]

43. Palmer S, Vecchio M, Craig JC, et al. Prevalence of depression in chronic kidney disease: Systematic review and meta-analysis of observational studies. *Kidney international* 2013;84:179-91. doi: 10.1038/ki.2013.77 [published Online First: 2013/03/15]

44. Roy T, Lloyd CE. Epidemiology of depression and diabetes: A systematic review. *Journal of affective disorders* 2012;142 Suppl:S8-S21. doi: 10.1016/s0165-0327(12)70004-6 [published Online First: 2012/10/25]

45. Atlantis E, Baker M. Obesity effects on depression: Systematic review of epidemiological studies. *International journal of obesity (2005)* 2008;32:881-91. doi: 10.1038/ijo.2008.54 [published Online First: 2008/04/17]

46. de Wit L, Luppino F, van Straten A, et al. Depression and obesity: A meta-analysis of community-based studies. *Psychiatry research* 2010;178:230-35. doi: 10.1016/j.psychres.2009.04.015 [published Online First: 2010/05/14]

47. Luppino FS, de Wit LM, Bouvy PF, et al. Overweight, obesity, and depression: A systematic review and meta-analysis of longitudinal studies. *Archives of general psychiatry* 2010;67:220-29. doi: 10.1001/archgenpsychiatry.2010.2 [published Online First: 2010/03/03]

48. Lee S, Tsang A, Huang YQ, et al. The epidemiology of depression in metropolitan China. *Psychol Med* 2009;39(5):735-47. doi: 10.1017/S0033291708004091 [published Online First: 2008/08/20]

49. Charlson FJ, Baxter AJ, Cheng HG, et al. The burden of mental, neurological, and substance use disorders in China and India: a systematic analysis of community representative epidemiological studies. *Lancet* 2016 doi: 10.1016/S0140-6736(16)30590-6

50. Wang T, Xiao S, Yang C, et al. Prevalence and incidence of depression disorder and cognitive impairment in the elderly in Shanghai, China. *Alzheimer's & Dementia* 2015;11(7):P832-P33.

51. Li J, Cacchione PZ, Hodgson N, et al. Afternoon napping and cognition in Chinese older adults: Findings from the China Health and Retirement Longitudinal Study Baseline Assessment. *Journal of American Geriatrics Society* 2017;65:373-80. doi: 10.1111/jgs.14368 [published Online First: 2016/12/21]

52. Avasthi A, Grover S. Clinical practice guidelines for management of depression in elderly. *Indian journal of psychiatry* 2018;60:S341-S62. doi: 10.4103/0019-5545.224474 [published Online First: 2018/03/15]

53. Zhang Y, Ting RZ, Yang W, et al. Depression in Chinese patients with type 2 diabetes: Associations with hyperglycemia, hypoglycemia, and poor treatment adherence. *Journal of diabetes* 2015;7:800-8008. doi: 10.1111/1753-0407.12238 [published Online First: 2014/10/29]

54. Fischer MJ, Kimmel PL, Greene T, et al. Elevated depressive affect is associated with adverse cardiovascular outcomes among African Americans with chronic kidney disease.

Kidney international 2011;80:670-78. doi: 10.1038/ki.2011.153 [published Online First: 2011/06/03]

Tables

Table 1. Baseline characteristics of the CHARLS participants free of depressive symptoms

Variable	Distribution
N	10,288
age, years, mean (SD)	58.5 (9.8)
Male, n (%)	5845 (50.7%)
Living in rural areas, n (%)	8,440 (73.3%)
Education, n (%)	
No formal education or illiterate	2,736 (23.7%)
Some primary school	1,804 (15.7%)
Finished primary school	2,590 (22.5%)
Junior high school or above	4,394 (38.1%)
Currently married, n (%)	10,375 (90.0%)
Smoking status, n (%)	
Current smoker	3,629 (31.5%)
Former smoker	1,034 (9.0%)
Never smoking	6,868 (60.0%)
Drinking status, n (%)	
Regular drinkers	1,951 (17.9%)
Occasional drinkers	476 (4.4%)
Former drinkers	646 (5.9%)
Never drinking	7,833 (71.8%)
Weight, kg, mean (SD)	60 (11.8)
Height, m, mean (SD)	1.6 (0.1)
Body mass index, kg/m^2, mean (SD)	23.7 (4)
Sleeping duration, hours, mean (SD)	6.7 (1.7)
CES-D short form score	5.1 (3.3)
Self-perceived health status, n (%)	
Excellent	483 (4.2%)
Very good	1,744 (15.1%)
Good	4,136 (35.9%)
Fair	3,977 (34.5%)
Poor	1,187 (10.3%)
Chronic conditions, n (%)	
Hypertension	4,045 (40.3%)
Dyslipidemia	1,016 (9.0%)
Diabetes	1,210 (15.0%)
Cancer	97 (0.8%)
Liver disease	387 (3.4%)
Heart disease	1,162 (10.1%)
Stroke	188 (1.6%)
Kidney disease	563 (4.9%)

Gastrointestinal disease	2,180 (18.9%)
Dementia	105 (0.9%)
Arthritis	3,221 (28.0%)
Asthma	312 (2.7%)

Note. CES-D=Center for Epidemiologic Study of Depression short form; SD=standard deviation.

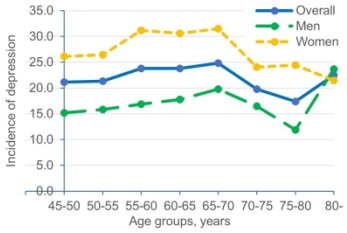
Table 2. Incidence of depressive symptoms among the CHARLS participants

	Ever having depressive Symptoms	Depressive symptoms in both visits 2 & 3	Depressive symptoms in 2 years	Depressive symptoms in 4 years
Overall	22.3 (21.3-23.3)	4.4 (4.0-4.9)	13.2 (12.5-14.1)	16.8 (15.9-17.7)
Rural	25.7 (24.6-26.8)	5.3 (4.8-5.8)	15.3 (14.3-16.2)	18.8 (17.8-19.8)
Urban	15.3 (13.4-17.2)	2.6 (1.9-3.3)	9.0 (7.4-10.6)	12.2 (10.4-14.1)
Men	16.7 (15.5-17.9)	3.0 (2.5-3.5)	9.9 (9.0-10.9)	12.2 (11.1-13.2)
Women	27.9 (26.4-29.4)	5.8 (5.1-6.6)	16.6 (15.3-17.9)	21.5 (20.1-22.9)

Table 3. Raw and multi-variates adjusted associations with the incidence of depressive symptoms in 4 years of follow-up.

	Multi-Variate Adjusted		*Raw Association*	
Variables	OR (95% CI)	P	OR (95% CI)	*P*
Age, per year older	0.99 (0.98-0.99)	**0.001**	0.99 (0.99-1.00)	0.59
Male vs. Female	0.60 (0.51-0.71)	**<.0001**	0.51 (0.46-0.56)	**<.0001**
Education level				
No formal education or illiterate	ref.	**<.0001**	ref.	**<.0001**
Some primary school	1.06 (0.90-1.25)		0.93 (0.80-1.08)	
Finished primary school	0.83 (0.71-0.97)		0.67 (0.57-0.77)	
Junior high school or above	0.71 (0.61-0.84)		0.48 (0.42-0.55)	
Rural vs. Urban	1.61 (1.38-1.88)	**<.0001**	1.72 (1.50-1.96)	**<.0001**
Not married vs Married	1.25 (1.04-1.51)	**0.02**	1.28 (1.08-1.51)	**0.004**
Smoking status				
Non-smokers	ref.		ref.	
Current smokers	1.02 (0.86-1.20)	**0.03**	0.51 (0.41-0.62)	**<.0001**
Former smokers	0.75 (0.59-0.96)		0.68 (0.60-0.76)	
Drinking status				
Never drinkers	Ref.		ref.	
Former drinkers	1.02 (0.80-1.30)	0.15	0.84 (0.67-1.04)	**<.0001**
Occasional drinkers	0.79 (0.59-1.06)		0.59 (0.45-0.78)	
Regular drinkers	0.85 (0.71-1.01)		0.59 (0.51-0.68)	
Body mass index, per 1 kg/m^2 increase	0.99 (0.98-1.01)	0.20	0.99 (0.98-1.00)	0.14
Self-perceived health status				
Excellent	0.36 (0.25-0.52)	**<.0001**	0.28 (0.20-0.39)	**<.0001**
Very good	0.36 (0.29-0.45)		0.28 (0.23-0.35)	
Good	0.53 (0.44-0.63)		0.45 (0.38-0.53)	
Fair	0.61 (0.52-0.73)		0.56 (0.48-0.66)	
Poor	ref.		ref.	
Sleep duration, per hour longer	0.89 (0.87-0.92)	**<.0001**	0.88 (0.85-0.90)	**<.0001**
Hypertension (Y vs. N)	1.07 (0.95-1.21)	0.25	1.07 (0.96-1.18)	0.22
Dyslipidemia (Y vs. N)	0.85 (0.69-1.04)	0.12	0.91 (0.76-1.09)	0.29
Diabetes (Y vs. N)	1.19 (1.00-1.42)	**0.04**	1.11 (0.95-2.30)	0.19
Cancer (Y vs. N)	0.92 (0.48-1.77)	0.80	1.17 (0.65-2.12)	0.61
Chronic Lung Disease (Y vs. N)	1.18 (0.97-1.44)	0.10	1.33 (1.12-1.58)	**0.001**
Chronic Liver Disease (Y vs. N)	0.90 (0.67-1.22)	0.51	1.04 (0.79-1.37)	0.81
Heart Disease (Y vs. N)	1.06 (0.88-1.28)	0.54	1.27 (1.08-1.49)	**0.004**
Stroke (Y vs. N)	0.88 (0.56-1.39)	0.59	1.12 (0.75-1.66)	0.58
Chronic Kidney Disease (Y vs. N)	1.32 (1.04-1.67)	**0.02**	1.45 (1.16-1.80)	**0.001**
Chronic Digestive Disorders (Y vs. N)	1.15 (1.01-1.31)	**0.04**	1.43 (1.26-1.61)	**<.0001**
Psychological Disorders (Y vs. N)	1.00 (0.53-1.89)	0.99	1.44 (0.81-2.56)	0.22
Dementia (Y vs. N)	1.31 (0.72-2.38)	0.37	1.15 (0.67-1.97)	0.62
Arthritis (Y vs. N)	1.43 (1.28-1.61)	**<.0001**	1.72 (1.54-1.91)	**<.0001**
Asthma (Y vs. N)	1.25 (0.90-1.75)	0.19	1.43 (1.06-1.91)	**0.02**

Note. CI=confidence interval; OR=odds ratio



254x190mm (300 x 300 DPI)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort 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	3
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	6-7
Objectives	3	State specific objectives, including any prespecified hypotheses	7
Methods			
Study design	4	Present key elements of study design early in the paper	8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	8-9
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	8
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	9-11
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	9
Bias	9	Describe any efforts to address potential sources of bias	17
Study size	10	Explain how the study size was arrived at	8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	12
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	12
		(*b*) Describe any methods used to examine subgroups and interactions	NA
		(*c*) Explain how missing data were addressed	NA
		(*d*) If applicable, explain how loss to follow-up was addressed	NA
		(*e*) Describe any sensitivity analyses	NA
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	8
		(b) Give reasons for non-participation at each stage	NA
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	13
		(b) Indicate number of participants with missing data for each variable of interest	NA
		(c) Summarise follow-up time (eg, average and total amount)	8
Outcome data	15*	Report numbers of outcome events or summary measures over time	NA
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	11, 13-14
		(*b*) Report category boundaries when continuous variables were categorized	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	14
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	17
Generalisability	21	Discuss the generalisability (external validity) of the study results	17
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	20

*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.

BMJ Open

Incidence and risk factors of depressive symptoms in four years of follow-up among mid-aged and elderly community-dwelling Chinese adults: Findings from the China health and Retirement Longitudinal Study

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2019-029529.R3
Article Type:	Research
Date Submitted by the Author:	06-Jul-2019
Complete List of Authors:	Wen, Yue; West China Hospital, Sichuan University, Department of Gastrointestinal Surgery Liu, Chunjuan; West China Hospital, Sichuan University, Department of Gastrointestinal Surgery Liao, Jing; West China Hospital, Sichuan University, Department of Gastrointestinal Surgery Yin, Yiqiong; West China Hospital, Sichuan University, Department of Gastrointestinal Surgery Wu, Dongmei; University of Electronic Science and Technology of China, The Clinical Hospital of Chengdu Brain Science Institute, MOE Key Lab for Neuroinformation; The Fourth People's Hospital of Chengdu & Chengdu Mental Health Center, Psychiatric Research Laboratory
Primary Subject Heading:	Mental health
Secondary Subject Heading:	Epidemiology
Keywords:	depressive symptoms, incidence, mid-aged and older adults, China

Incidence and risk factors of depressive symptoms in four years of follow-up among mid-aged and elderly community-dwelling Chinese adults: Findings from the China Health and Retirement Longitudinal Study

Yue Wen, Chunjuan Liu, Jing Liao, Yiqiong Yin*, Dongmei Wu*

Correspondence should be made to:

Dongmei Wu, PhD, RN

Department of Nursing, The Clinical Hospital of Chengdu Brain Science Institute, MOE Key Lab for Neuroinformation, University of Electronic Science and Technology of China

Huli West 1st Lane, Chengdu, Sichuan Province, China, 610036.

Tel: 86-28-69515754

E-mail: wudongmei_2001@163.com

Yiqiong Yin, BN, RN

Chief Superintendent Nurse, Department of Gastrointestinal Surgery, West China Hospital, Sichuan University

37 Guoxue Xiang Street, Chengdu, Sichuan Province, China, 610041.

Tel: 86-28-85422877

E-mail: yiqiong489@163.com

*: Yiqiong Yin and Dongmei Wu were co-corresponding authors for this manuscript.

The full names, institutions, city, and country of all other co-authors:

Yue Wen, BN, RN

Supervisor Nurse, Department of Gastrointestinal Surgery, West China Hospital, Sichuan University

37 Guoxue Xiang Street, Chengdu, China, 610041. E-mail: wenyue19820327@163.com

Chunjuan Liu, BN, RN

Supervisor Nurse, Department of Gastrointestinal Surgery, West China Hospital, Sichuan University

37 Guoxue Xiang Street, Chengdu, China, 610041. E-mail: liuchunjuan2002@163.com

Jing Liao, MSN, RN

Senior Nurse, Department of Gastrointestinal Surgery, West China Hospital, Sichuan University

37 Guoxue Xiang Street, Chengdu, China, 610041. E-mail: m15982277765@163.com

Yiqiong Yin, BN, RN

Chief Superintendent Nurse, Department of Gastrointestinal Surgery, West China Hospital, Sichuan University

37 Guoxue Xiang Street, Chengdu, China, 610041. E-mail: yiqiong489@163.com

Dongmei Wu, PhD, RN

Assistant Professor, Department of Nursing, The Clinical Hospital of Chengdu Brain Science Institute, MOE Key Lab for Neuroinformation, University of Electronic Science and Technology of China

Huli West 1st Lane, Chengdu, China, 610036. Tel: 86-28-69515754. E-mail: wudongmei_2001@163.com

Word count: 7493

Abstract

Objectives. The purpose of this study was to examine the incidence of depressive symptoms, and determine if baseline risk factors conferred a risk for incident depressive symptoms over time in a nationally representative sample of mid-aged and elderly Chinese population.

Design. This study was a secondary analysis of a prospective cohort from a nationally representative sample.

Setting. Community samples in 28 provinces of China were recruited from the baseline survey of the China Health and Retirement Longitudinal Study. A four-stage, stratified, cluster probability sampling strategy was used, which included 10,257 households with members aged 45 years or older and their spouse.

Participants. A total of 11,533 participants free of depressive symptoms at baseline were identified, and 10,288 were re-examined in either the first and/or the second follow-up surveys. The current analyses were conducted among the 10,288 participants.

Primary and secondary outcome measures. Depressive symptoms were measured by the Center for Epidemiological Studies Depression Scale short form.

Results. The findings showed that the incidence of depressive symptoms in a 4-year follow-up was as high as 22.3%. The incidence was much higher in rural areas (25.7%) and in women (27.9%). Furthermore, participants with an hour longer of sleeping had a 10% lower risk of developing depressive symptoms. Compared to individuals who perceived their health status as poor, those who perceived their health status as excellent had 62% lower risk of developing depressive symptoms. In addition, diabetes (OR=1.19, p=.04) and chronic kidney disease (OR=1.32, p=.02) at baseline increased the risk of depressive symptoms. However, baseline body mass index was not associated with the onset of depressive symptoms in this population.

Conclusions. This study highlight the importance of developing an appropriate screening test to identify depressive symptoms for those who are vulnerable and ensure these individuals can receive early interventions for depressive symptoms.

Key words: depressive symptoms, incidence, mid-aged and older adults, China

Strengths and limitations of this study

- Since the sample was representative of community-dwelling mid-aged and older Chinese adults, the study results can be generalized to mid-aged and older Chinese adults.
- Depressive symptoms were based on self-reports instead of clinically diagnosis. Therefore, information bias may be present. However, with longitudinal design, information bias in the current study was very likely to be non-differential.
- This study was a prospective analysis of baseline risk factors with depressive symptoms at follow-up, and no causal associations between these predictors and depressive symptoms can be drawn from the analysis.

Introduction

Depression has been recognized as a leading cause of disability and a major contributor to disease burdens globally [1]. An estimated 322 million adults had depression in 2015 worldwide, with nearly half of these people living in the South-East Asia and Western Pacific regions [2]. In China, about 4.2% adult population was estimated to be depressed, and the prevalence of depression reached a peak in older adulthood [2]. With fast economic growth, mid-aged adults are exposed to a high-stress lifestyle, which is thought to contribute significantly to an increase in mental health disorders in susceptible people [1]. Older adults, on the other hand, face noteworthy challenges to their life, including loss of independence, loss of social support due to the death of a spouse or weakened family connectedness (traditionally referred to as 'filial piety'), financial difficulties, and medical vulnerability [3]. Late-life depressive symptoms increase risk for significant impairment in social function [3], dementia [4], declined quality of life [5], and suicide [6]. They further complicate the prognosis of concurrent medical problems by increasing physical disability and decreasing motivation and adherence to prescribed medications and/or exercise or rehabilitation programs [7 8].

Although depression has come to be regarded as the common cold of psychosocial functioning in Western culture, mental disorders are still viewed as degrading not only to the patient, but also to the entire family in Chinese culture [9 10]. In addition, although effective interventions have been developed to alleviate symptoms of depression, depressive symptoms are often overlooked among the elderly, since most of them mistakenly consider these symptoms to be part of the normal ageing process [11]. Therefore, older adults may not actively seek medical treatment and leave their depressive symptoms undiagnosed or untreated. As persons aged 45 or older will increase from 32% to 51% of the total population from 2010 to 2040 in China [12],

reliable and up-to-date estimates of the proportion of this population affected by depressive symptoms are a key ingredient of effective health policy, planning, and evaluation.

Recently, a number of population-based studies have estimated prevalence of depressive symptoms among mid-aged and older Chinese adults [3 11 13 14]. Given that all these studies were cross-sectional, the incidence of depressive symptoms among mid-aged and older Chinese adults was not clear. Furthermore, despite a myriad of studies that examined a number of health conditions associated with an increased risk of mid- and late-life depressive symptoms, including chronic diseases, overweight/obesity, sleep duration, and self-perceived health status [3 14-17], the prospective relationships between these health conditions and depressive symptoms have not been well understood in this population. Such prospective relationships may provide further evidence on how baseline conditions may be predictive of depressive symptoms in the follow-up than cross-sectional analysis, especially given that these health conditions are expected to be a great challenge to an increasing aging population, and can often co-occur with depressive symptoms which may make these conditions worse [3]. A better understanding of these associations may also provide information that is useful in identifying patients who are vulnerable to mid-life or late-life depressive symptoms, and proactively assessing and treating modifiable risk factors during primary health care service.

Therefore, the purpose of this study was to examine the incidence of depressive symptoms among mid-aged and older adults in China, and determine if baseline sleep duration, body weight, self-perceived health status, and chronic conditions conferred a risk for incident depressive symptoms over time, using baseline and four years of follow-up data from the China Health and Retirement Longitudinal Study (CHARLS).

Methods

Study Design

This study was a secondary analysis of prospective data from the CHARLS. The CHARLS is a nationwide, community-engaged, population-based epidemiological study of Chinese adults aged 45 years or older. The purpose of the CHARLS was to obtain detailed information regarding the dynamics of retirement and how it interacts with health, health insurance, and economic well-being. The CHARLS collects detailed information on a wide range of domains, including demographics, health status, physical measures, employment history, pension insurance, retirement, income, expenditures and assets [18]. The current study used data from baseline, the first, and the second follow-up surveys.

Participants

The CHARLS national baseline survey was conducted in 28 provinces (Tibet, Ningxia, and Hainan were not included) across the country from May 2011 to March 2012. It was a survey of 10,257 households with members aged 45 years or older and their spouse, for a total of about 17,708 individuals. A four-stage, stratified, cluster probability sampling strategy was used to select eligible participants [18]. Details of the sampling procedure are published elsewhere [19]. In brief, in the first stage, all counties were grouped by gross domestic product and by urban or rural regions. In the second stage, counties were stratified and sampled using probabilities proportional to size (PPS). Three rural villages and urban neighborhoods were randomly selected as primary sampling units (PSUs) using PPS in each county. In the third stage, all buildings in each PSU were recognized on Google Earth. A sample of 24 households was randomly selected among all households in each PSU. In the final stage, a short screening form was employed to ensure study eligibility in selected households and members of 45 years of age or above were

invited to enroll into the study. The response rate for the survey was over 80% (94% in rural areas and 69% in urban areas) [18].

The baseline cohort of the CHARLS participants was followed up every two years with the same survey questionnaires and biomedical measures [18]. The first follow-up survey of the CHARLS was fielded between July 2013 and January 2014. Subjects in this study used the same inclusion and exclusion criteria as the original study. A total of 11,533 participants free of depressive symptoms at baseline were identified, of whom 9,329 participated in the first follow-up survey in 2013-2014, 9,157 were examined in the second follow-up survey in 2015-2016, and 10,288 were followed in either the first or the second follow-up surveys. The current analyses were conducted among the 10,288 participants.

Patient and Public Involvement

Participants with abnormal findings, including depressive symptoms were suggested to visit a physician for further clinical evaluation. In the current study, we used de-identified data from the CHARLS with no direct involvement of or interaction with participants in the design, recruitment or conduct of the original cohort study.

Variables, Definitions, and Measures

Depressive symptoms. The Center for Epidemiological Studies Depression Scale (CES-D) short form was used to measure depressive symptoms [20]. The CES-D short form consists of ten items, and each item is rated on a four-point Likert scale with answers ranging from 0 (rarely or none of the time) to 3 (most or all of the time) with the total possible summary score of 0 to 30. The time frame for the CES-D short form refers to the week prior to interview. Item 5 ("feeling hopeful about the future") and 8 ("feeling happy") are reversely scored before analysis.

Higher scores corresponds to higher levels of depressive symptoms, and a score of 12 or higher has been used as the cut-off point for depressive symptoms [21].

The CES-D short form has been validated among a subsample of 742 CHARLS participants aged 60 years and older, showing adequate psychometric properties [21]. Confirmatory factor analysis showed that the two-factor model had the best fit. Depressive affect and somatic retardation were loaded as the first factor, and positive affect was loaded as the second factor. The two-factor structure varied across both genders in multi-group analysis (χ^2= 144.13, $p<0.001$). R^2 coefficient was used to measure the reliability of each item, and some of them differed between both gender groups. For example, depressive affect and somatic retardation accounted for 37% and 64% of the variance in the depression indicator ("bothered") for the males and females, respectively [21].

Measure of health conditions associated with depressive symptoms. These factors included chronic conditions, overweight/obesity, sleep duration, and self-perceived health status. Information on chronic conditions was primarily based on self-reports except hypertension and diabetes. Participants were asked if they had been diagnosed with any of the following health conditions: arthritis, dyslipidemia, cancer (excluding minor skin cancers), liver diseases (except for fatty liver, tumors or cancer), cardiovascular diseases (heart attack, coronary heart disease, angina, congestive heart failure, or other heart problems), stoke, kidney disease (except for cancer or tumor), stomach or other gastrointestinal diseases (except for tumor or cancer), memory-related diseases, and asthma. Participants answered "yes" to these questions were defined as having these doctor-diagnosed conditions.

Hypertension was defined based on the most current guidelines from the American Heart Association, which have lowered the threshold of hypertension cut-off points to 130/80 mmHg [22].

A systolic blood pressure measurement of 130 mmHg and higher, or a diastolic measurement of 80 mmHg and higher, or 130/80 mmHg and higher, or taking antihypertensive medications including modern western medicine, traditional Chinese medicine, or using other treatment for hypertension was considered as having hypertension [22]. Blood pressure was measured three times (approximately 45 seconds apart) for each participant on the left arm in sitting position, using an electronic blood pressure monitor (Omron™ HEM-7112) [23].

The diagnosis of diabetes was based on the current guidelines from the American Diabetes Association (2018). Readings of 126 mg/dL or higher for fasting blood glucose ≥126 mg/dL, or readings of 200 mg/dL or higher for random blood glucose, or readings of 6.5% or higher for glycated hemoglobin, or use of insulin, or taking oral hypoglycemic medications including traditional Chinese medicine, modern western medicine, or other diabetes treatment was considered as having diabetes [24].

Weight was measured to the nearest 0.1 kg using a digital scale (Omron™ HN-286, Yangzhou, China) on an even, uncarpeted surface, with participants removing heavy outer clothing. Height was measured without shoes to the nearest 0.1 cm using a stadiometer (Seca™213, Hangzhou, China). Body mass index (BMI, weight in kilograms divided by height in meters squared) was calculated from the participants' weight and height.

Self-perceived health status is a powerful indicator of the health status of elderly people [25]. It was measured based on self-reports to the following question, “Would you rate health as…”,with five response options provided: excellent, very good, good, fair, and poor.

Sleep duration in hours was collected using a question, “During the past month, how many hours of actual sleep did you get at night (average hours for one night)? (This may be shorter than the number of hours you spend in bed.)”

Covariates. Factors that could confound the main association were identified a priori from current literature. Covariates included age, gender [3], education [26], and marital status [3 27]. Consistent with a prior CHARLS publications [28 29], education was categorized as illiterate or no formal education, some primary school but can read and write, primary school including home schooling, and middle school or above. Marital status was grouped as married versus not married.

Ethical Considerations

The CHARLS was approved by the Peking University Ethical Review Committee. The current study is a secondary analysis of the de-identified CHARLS public data. The Ethics Review Committee granted the current study exemption from review.

Statistical Analysis

Incidence of depressive symptoms. The incidence of depressive symptoms was analyzed taking into account the complex survey design and nonresponse rate in both estimates and the corresponding standard errors (SEs). Participants were categorized into 5-year age groups. SAS PROC SURVEYFREQ procedure was used to obtain the overall and gender specific incidence of depressive symptoms among all participants and by the 5-year age groups. In addition, overall and gender-specific incidence of depressive symptoms was estimated by rural and urban areas. We estimated the incidence of four outcomes of depressive symptoms: having depressive symptoms in the first follow-up survey (2013-2014); having depressive symptoms in the second follow-up survey (2015-2016); ever having depressive symptoms in the first or the second follow-up survey; and consistently having depressive symptoms in both follow-up surveys.

Prospective analysis. Baseline characteristics of the participants were summarized as frequency and percentage for categorical variables and mean and standard deviation or median

and interquartile range for continuous variables. Associations of baseline health behaviors, including chronic conditions, overweight/obesity, sleep duration, and self-perceived health status, with the incidence of ever having depressive symptoms in 4 years of follow-up were evaluated by a multivariate logistic regression model, while controlling for all covariates as mentioned above. Odds ratios (ORs) and the corresponding 95% confidence intervals (CIs) were reported. The SAS 9.4 (SAS Institute Inc., Cary, North Carolina) was used to perform the analyses. All the p values were two-sided, and $p<0.05$ was considered significant.

Results

Sample Characteristics

A total of 10,288 participants aged 45 years or older were included in the estimate of depressive symptoms incidence. As shown in Table 1, the average age of all participants was 58.5 years and roughly half participants (49.3%) were women. Most of the participants (73.3%) lived in rural areas and 60.6% participants had education of primary school or above. The majority of participants (90.0%) were married or living with a partner at the time of data collection. About a third of the participants (31.5%) were current smokers and 17.9% were current regular drinkers. Participants had an average BMI of 23.7 kg/m^2. The mean duration of sleep per night was 6.7 hours, and less than 20% of participants perceived their health as very good or excellent. The mean CES-D short form score was 5.1 at baseline.

Incidence of Depressive Symptoms

As shown in Table 2 and in Figure 1, the incidence of ever having depressive symptoms in 4 years was 22.3% (95% CI: 21.3%-23.3%). The incidence was much higher in rural areas than that in urban areas (25.7% vs. 15.3%, $p<.0001$). Women had higher incidence of depressive symptoms than men (27.9% vs. 16.7%, $p<.0001$). There is no clear pattern of the incidence of

depressive symptoms over age groups (Figure 1). The incidence was highest among the 65-70 years of age group and lowest among the 45-50 years of age group.

Baseline Risk Factors and Incident Depressive Symptoms

As shown in Table 3, in the fully adjusted multivariable logistic regression model, sleeping duration and self-perceived health status were both inversely associated with the risk of depressive symptoms. Specifically, participants with an hour longer of sleeping had a 10% (95% CI: 7%-13%, p<.0001) lower risk of developing depressive symptoms in 4 years of follow up. Compared to individuals who perceived their health status as poor, those who perceived their health status as fair, good, very good, and excellent had 42% (95% CI: 39%-52%), 47% (95% CI: 36%-57%), 64% (95% CI: 54%-72%), and 62% (95% CI: 43%-74%) lower risk of developing depressive symptoms, respectively. In addition, three chronic conditions, diabetes (OR=1.19, 95% CI: 1.00-1.42, p=.04), chronic kidney disease (OR=1.32, 95% CI: 1.04-1.67, p=.02), chronic digestive disorders (OR=1.15, 95% CI: 1.01-1.31, p=.04), and arthritis (OR=1.43, 95% CI: 1.28-1.61, p<.0001) were associated with higher risk of depressive symptoms. However, baseline BMI was not associated with the onset of depressive symptoms in this population (OR=0.99, 95% CI: 0.97-1.01). Chronic lung disease (p=.001), chronic liver disease (p=.004), and asthma (p=.02) were positively associated with incidence of depressive disorder in the raw analysis, but became non-significant in the fully adjusted model (all p>.05).

Discussion

Through analysis to data of a nationally representative sample of mid-aged and older Chinese adults, we found that the incidence of depressive symptoms in a 4-year follow-up was as high as 22.3%. Large disparities in the incidence of depressive symptoms were observed between rural and urban areas and between men and women. Furthermore, longer sleeping

duration and better self-perceived health status were both associated with lower risk of depressive symptoms. In addition, diabetes and chronic kidney disease at baseline increased the risk of depressive symptoms. However, baseline BMI was not associated with depressive symptoms in this population.

Our study found that in 4 years of follow-up, as high as 22.3% of the mid-aged and older Chinese adults developed depressive symptoms. Using the same database, a recent study reported that the prevalence of depressive symptoms at CHARLS baseline survey was up to 26.2% [13]. Collectively, these findings revealed that depressive symptoms were a major public health challenge in China, and intervention programs should be developed to reduce the burden of depressive symptoms. Furthermore, large disparities were also observed between rural and urban residents and between men and women. In particular, women and residents living in rural areas were at a higher risk of developing depressive symptoms. The high incidence rate is not only relevant to middle-aged and older Chinese adults, it also has implications for younger generations of the Chinese. Many depressive symptoms cases remained undiagnosed, and even among those who were aware of the condition, very few sought treatments due to cultural stigma [9 10] . Middle-aged and elderly grandparents are the primary caregivers of infants, toddlers, and young children in rural China. Depressed caregivers were more likely to show negative parenting interactions (e.g., limited facial and behavioral affect) with their children, and these interactions were directly relevant for children's development [30 31]. A strong negative correlation has been reported between the levels of depression of grandmothers and the levels of developmental outcomes of the grandchildren in their care, including cognitive, language, social-emotional, and motor functions [32 33]. Taken together, changes in social policies and intervention programs

should be developed to address timely diagnosis and treatment of depression for these people, which will help improve young children's developmental outcomes in rural China.

Individuals with longer sleep duration had lower risk of depressive symptoms. This finding is in line with previous studies [34 35]. Sleep disorders are often the presenting and core symptoms of depression [36]. However, treatment of depression did not resolve sleep symptoms, which may confer a greater risk for depression recurrence and relapse [36]. Therefore, sleep deprivation should be at least considered as an early indicator of depressive symptoms. Individuals with sleep deprivation should be aware of their high risk of depressive symptoms and manage to improve the length of their sleeping.

Better self-perceived health status also reduced the risk of depressive symptoms in the current study. The finding is consistent with studies among other populations [37 38]. Self-perceived health is a powerful indicator of the overall health status of elderly people [25]. Many factors, including sociodemographic characteristics, chronic disease, functional status, social relationships, neighborhood environment, and nutrition pattern, were all important determinants of self-perceived health [25]. These factors are also associated with depressive symptoms. The current study adjusted most of the factors, except for functional status, social relationship, and nutrition pattern, which were not available in the CHARLS database. However, poorer self-perceived health status was still significantly associated with higher risk of depressive symptoms. Future studies additionally controlling for those factors will help to evaluate the contribution of those factors on the associations of self-perceived health status with depressive symptoms. Furthermore, such study may also help delineate whether self-perceived health status may represent other factors that may lead to depressive symptoms. Finally, individuals with depressive disorders were more likely to report poor self-perceived health [39 40]. Therefore, there

might be a bidirectional association between depressive symptoms and self-perceived health. Future studies examining the bi-directional relationship are warranted.

Among 12 chronic conditions, baseline chronic kidney disease increased the risk of depressive symptoms at follow-up. Although the underlying mechanisms have not been well understood, some authors suggested that the psychosocial and biologic changes in dialysis may explain this relationship [41]. In addition to chronic kidney disease, baseline diabetes also conferred a higher risk of symptoms of depression over time in this study. Similar results were reported in a meta-analysis of 11 studies, which found that people with diabetes at baseline had a 24% higher risk of developing depression at follow-up compared to those without diabetes [42]. In addition, high prevalence of depression among people with diabetes and/or chronic kidney disease has also been observed in cross-sectional studies [43-45]. In concordance with these findings, this study added further evidence that compared to other chronic conditions at baseline, baseline chronic disease and diabetes were more likely to be associated with depressive symptoms over time in a population of mid-aged and older Chinese population.

Overweight/obesity is well established to interfere with mental health, with depressive symptoms being more common among overweight/obese individuals than their normal-weight counterparts, especially in overweight/obese women [46 47]. A meta-analysis of longitudinal studies further confirmed this relationship, in which excess weight at baseline increased a higher risk for incident depression at follow-up [48]. In contrast to these findings from Western and European countries, using data from a prospective survey of a large, representative sample of mid-aged and elderly community-dwelling residents in Mainland China, we did not find a relationship between baseline BMI and subsequent depressive symptoms over time. These inconsistent findings may suggest that because participants in the current study were predominantly low in BMI at baseline

(mean BMI was 23.7 kg/m^2), their likelihood of experiencing depressive symptoms may have been lower compared to those participants reported in Luppino et al [48]. However, these are preliminary findings that need to be further investigated in future prospective studies in this population.

The study has several important strengths. First, to the best of our knowledge, this is the first study that examined the incidence of depressive symptoms in a nationally representative population in China. Previous studies have focused on the estimation of depressive symptoms prevalence [49 50] or investigated the incidence of depressive symptoms in a regional sample [51]. Second, since the sample was representative of community-dwelling mid-aged and older Chinese adults, the results can be generalized to mid-aged and older Chinese adults. Third, a Chinese specific cut-off point of the CES-D short form score for depressive symptoms has been used, and the cut-off point was validated among middle-aged and older Chinese adults [21]. Therefore, our study provided more reliable estimate of the incidence of depressive symptoms. Finally, strict quality control measures, including GPS matching, data checking, recording and checking interviews, and calling back participants, were implemented at each stage of the study to ensure data quality and reliability.

There were also some limitations in this study that should be acknowledged. First, depressive symptoms were based on self-reports instead of clinically diagnosis. Therefore, information bias may be present. However, with longitudinal design, information bias in the current study was very likely to be non-differential. Since non-differential misclassification generally bias the association estimates towards the null, our study findings were more robust. Second, nighttime sleep duration was also measured based on self-reports. The use of self-reported measures in the CHARLS surveys may have biased study results, since participants may

consistently under- or overestimate their nighttime sleep duration [52]. Objective or direct measures of sleep duration should be used to increase precision and accuracy of self-report assessment. Finally, this study was a prospective analysis of baseline risk factors with depressive symptoms at follow-up, and no causal associations between these predictors and depressive symptoms can be drawn from the analysis.

The findings of the current study have important implications for clinical practice. Health care professionals are especially encouraged to address the needs for better mental health in elderly population [53]. In view of the high incidence of depressive symptoms (22.3%) among mid-aged and elderly Chinese, the findings of this study highlight the importance of developing an appropriate screening test to identify depressive symptoms for those who are vulnerable and ensure these individuals can receive early interventions for depressive symptoms. The screening test should include items such as areas of living (rural or urban areas), gender, age groups, nighttime sleep duration, self-perceived health status, and certain chronic conditions, especially chronic kidney disease and diabetes. In addition, intervention strategies that address short nighttime sleep duration may be used to alleviate depressive symptoms and improve mental health in this population. Intervention programs should also be prioritized to target at specific populations, such as women and residents living in rural areas, as these populations were at a higher risk of developing depressive symptoms. Finally, new patients with chronic kidney disease and diabetes should be screened for depression using the CES-D short form at initial visit. Persons with depressive symptoms (a score of 12 or higher) should then be assessed by a clinician using the structured clinical interview for Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition. Potential participants with serious depressive symptoms should be referred immediately to a mental health professional. Individuals with these two conditions are

particularly vulnerable to the deleterious effects of affective symptoms, since symptoms of depression is a known risk factor for noncompliance with medical treatment and adverse health outcomes [54 55].

Conclusions

To conclude, our study found a high incidence of depressive symptoms in 4 years of follow-up among a nationally representative mid-aged and older Chinese population. In addition, great disparities in the incidence of depressive symptoms were observed between individuals lived in rural and urban areas and between men and women. Furthermore, we identified that worse self-perceived health, shorter duration of sleeping, diabetes and chronic kidney disease at baseline increased the risk for depressive symptoms. These findings supported the importance of baseline status to longitudinal changes in depressive symptoms. Thus, interventions for vulnerable mid-aged and older adults should focus on addressing short nighttime sleep duration. These findings also help identify individuals at higher risk for depressive symptoms, such as those with chronic kidney disease and diabetes, or women and residents living in rural areas, so that early interventions can be implemented to prevent depressive symptoms.

Figure Legend

Figure 1. The Incidence of Depressive Symptoms in 4 Years of Follow-up among Participants of the CHARLS

Contributorship Statement

All authors contribute to the conception and design of this study. YW, YY, and DW were responsible for the design, analysis, drafting and revision of this manuscript. CL and JL were responsible for interpretation of data and preparation of the manuscript.

Competing Interests Statement

None declared.

Funding Statement

This work was supported by the Sichuan Science and Technology Program grant number 2018JY0306 to Dr. Dongmei Wu. The CHARLS is funded by Peking University, the National Natural Science Foundation of China, the Behavioral and Social Research Division of the National Institute on Aging, and the World Bank.

Acknowledgments

The authors would gratefully acknowledge the assistance Dr. Tingting Liu, an assistant professor at University of Arkansas Eleanor Mann School of Nursing for editing the manuscript.

Patient Consent for Publication

Not required.

Data Sharing Statement

The study used a public data from the CHARLS that were obtained from the CHARLS home page at http://charls.pku.edu.cn/en.

References

1. Qin X, Wang S, Hsieh C. The prevalence of depression and depressive symptoms among adults in China: Estimation based on a National Household Survey. *China Economic Review* 2016 doi: 10.1016/j.chieco.2016.04.001

2. World Health Organization. Depression and other common mental disorders: Global health estimates. Geneva, Swiss: World Health Organization 2017.

3. Lei X, Sun X, Strauss J, et al. Depressive symptoms and SES among the mid-aged and elderly in China: Evidence from the China Health and Retirement Longitudinal Study national baseline. *Social Science & Medicine* 2014;120:224-32. doi: 10.1016/j.socscimed.2014.09.028 [published Online First: 2014/09/28]

4. Diniz BS, Butters MA, Albert SM, et al. Late-life depression and risk of vascular dementia and Alzheimer's disease: Systematic review and meta-analysis of community-based cohort studies. *The British journal of psychiatry : the journal of mental science* 2013;202:329-35. doi: 10.1192/bjp.bp.112.118307 [published Online First: 2013/05/03]

5. Sivertsen H, Bjørkløf GH, Engedal K, et al. Depression and quality of life in older persons: A review. *Dementia and geriatric cognitive disorders* 2015;40:311-39. doi: 10.1159/000437299

6. Wang CW, Chan CL, Yip PS. Suicide rates in China from 2002 to 2011: An update. *Social psychiatry and psychiatric epidemiology* 2014;49:929-41. doi: 10.1007/s00127-013-0789-5 [published Online First: 2013/11/19]

7. Holzapfel N, Lowe B, Wild B, et al. Self-care and depression in patients with chronic heart failure. *Heart & Lung* 2009;38:392-97. doi: 10.1016/j.hrtlng.2008.11.001 [published Online First: 2009/09/17]

8. Gonzalez JS, Safren SA, Delahanty LM, et al. Symptoms of depression prospectively predict poorer self-care in patients with type 2 diabetes. *Diabetetic Medicine* 2008;25:1102-07. doi: 10.1111/j.1464-5491.2008.02535.x [published Online First: 2009/02/03]

9. Zeng B, Sun W, Gary RA, et al. Towards a conceptual model of diabetes self-management among Chinese immigrants in the United States. *International journal of environmental research and public health* 2014;11:6727-42. doi: 10.3390/ijerph110706727 [published Online First: 2014/07/01]

10. He P, Hu Y, Li C, et al. Predictors of depressive symptoms among mid-aged and older men with diabetes in China. *Research and theory for nursing practice* 2019;33(1):6-22. doi: 10.1891/1541-6577.33.1.6 [published Online First: 2019/02/24]

11. Xu Y, Yang J, Gao J, et al. Decomposing socioeconomic inequalities in depressive symptoms among the elderly in China. *BMC public health* 2016;16:1214. doi: 10.1186/s12889-016-3876-1 [published Online First: 2016/12/03]

12. United Nations Deparment of Economic and Social Affais/Population Division. World population prospects: The 2012 revision, volume II: Demophic profiles. New York, NY: United Nations 2012.

13. Li C, Miles T, Shen L, et al. Early-life exposure to severe famine and subsequent risk of depressive symptoms in late adulthood: The China Health and Retirement Longitudinal Study. *British Journal of Psychiatry* 2018;213:579-86. doi: 10.1192/bjp.2018.116 [published Online First: 2018/08/31]

14. Yu J, Li J, Cuijpers P, et al. Prevalence and correlates of depressive symptoms in Chinese older adults: A population-based study. *International journal of geriatric psychiatry* 2012;27:305-12. doi: 10.1002/gps.2721 [published Online First: 2011/05/04]

15. Alvaro PK, Roberts RM, Harris JK. A systematic review assessing bidirectionality between sleep disturbances, anxiety, and depression. *Sleep* 2013;36:1059-68. doi: 10.5665/sleep.2810 [published Online First: 2013/07/03]

16. Wilson-Genderson M, Heid AR, Pruchno R. Onset of multiple chronic conditions and depressive symptoms: A life events perspective. *Innovation in Aging* 2017;1:igx022-igx22. doi: 10.1093/geroni/igx022

17. Qian J, Li N, Ren X. Obesity and depressive symptoms among Chinese people aged 45 and over. *Scientific reports* 2017;7:45637. doi: 10.1038/srep45637

18. Zhao Y, Hu Y, Smith JP, et al. Cohort profile: The China Health and Retirement Longitudinal Study (CHARLS). *International journal of epidemiology* 2014;43:61-68. doi: 10.1093/ije/dys203 [published Online First: 2012/12/18]

19. Li C, Liu T, Sun W, et al. Prevalence and risk factors of arthritis in a middle-aged and older Chinese population: The China Health and Retirement Longitudinal Study. *Rheumatology (Oxford, England)* 2015;54:697-706. doi: 10.1093/rheumatology/keu391 [published Online First: 2014/10/08]

20. Andresen EM, Malmgren JA, Carter WB, et al. Screening for depression in well older adults: Evaluation of a short form of the CES-D (Center for Epidemiologic Studies Depression Scale). *American journal of preventive medicine* 1994;10(2):77-84. [published Online First: 1994/03/01]

21. Chen H, Mui AC. Factorial validity of the Center for Epidemiologic Studies Depression Scale short form in older population in China. *International psychogeriatrics / IPA* 2014;26:49-57. doi: 10.1017/s1041610213001701 [published Online First: 2013/10/16]

22. Whelton PK, Carey RM, Aronow WS, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults: Executive Summary: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *Circulation* 2018;138(17):e426-e83. doi: 10.1161/cir.0000000000000597 [published Online First: 2018/10/26]

23. Zhao Y, Crimmins E, Hu P, et al. China Health And Retirement Longitudinal Study: 2011-2012 national baseline blood data users' guide. Beijing, China: China Center for Economic Research, Peking Universtiy 2014.

24. American Diabetes Association. 2. Classification and diagnosis of diabetes: Standards of medical care in diabetes-2018. *Diabetes care* 2018;41:S13-S27. doi: 10.2337/dc18-S002 [published Online First: 2017/12/10]

25. Machón M, Vergara I, Dorronsoro M, et al. Self-perceived health in functionally independent older people: Associated factors. *BMC geriatrics* 2016;16:66. doi: 10.1186/s12877-016-0239-9 [published Online First: 2016/03/11]

26. Bjelland I, Krokstad S, Mykletun A, et al. Does a higher educational level protect against anxiety and depression? The HUNT study. *Social science & medicine (1982)* 2008;66:1334-45. doi: 10.1016/j.socscimed.2007.12.019 [published Online First: 2008/02/01]

27. Cheng HG, Chen S, McBride O, et al. Prospective relationship of depressive symptoms, drinking, and tobacco smoking among middle-aged and elderly community-dwelling adults: Results from the China Health and Retirement Longitudinal Study (CHARLS).

Journal of affective disorders 2016;195:136-43. doi: 10.1016/j.jad.2016.02.023 [published Online First: 2016/02/20]

28. Zuo M, Gan C, Liu T, et al. Physical predictors of cognitive function in individuals with hypertension: Evidence from the CHARLS basline survey. *Western journal of nursing research* 2019;41(4):592-614. doi: 10.1177/0193945918770794 [published Online First: 2018/05/11]
29. Zhang M, Liu T, Li C, et al. Physical performance and cognitive functioning among individuals with diabetes: Findings from the China Health and Retirement Longitudinal Study Baseline Survey. *Journal of advanced nursing* 2019;75(5):1029-41. doi: 10.1111/jan.13901 [published Online First: 2018/11/07]
30. Lovejoy MC, Graczyk PA, O'Hare E, et al. Maternal depression and parenting behavior: A meta-analytic review. *Clinical psychology review* 2000;20(5):561-92. [published Online First: 2000/06/22]
31. Pelaez M, Field T, Pickens JN, et al. Disengaged and authoritarian parenting behavior of depressed mothers with their toddlers. *Infant behavior & development* 2008;31(1):145-8. doi: 10.1016/j.infbeh.2007.06.002 [published Online First: 2007/07/27]
32. Yue A, Gao J, Yang M, et al. Caregiver depression and early child development: A mixed-methods study from rural China. *Frontiers in psychology* 2018;9:2500. doi: 10.3389/fpsyg.2018.02500 [published Online First: 2019/01/09]
33. Zhang S, Dang R, Yang N, et al. Effect of caregiver's mental health on early childhood development across different rural communities in China. *International journal of environmental research and public health* 2018;15(11) doi: 10.3390/ijerph15112341 [published Online First: 2018/10/27]

34. Sun Y, Shi L, Bao Y, et al. The bidirectional relationship between sleep duration and depression in community-dwelling middle-aged and elderly individuals: Evidence from a longitudinal study. *Sleep medicine* 2018;52:221-29. doi: 10.1016/j.sleep.2018.03.011 [published Online First: 2018/06/05]

35. Li Y, Wu Y, Zhai L, et al. Longitudinal association of sleep duration with depressive symptoms among middle-aged and older Chinese. *Scientific reports* 2017;7:11794. doi: 10.1038/s41598-017-12182-0 [published Online First: 2017/09/20]

36. Nutt D, Wilson S, Paterson L. Sleep disorders as core symptoms of depression. *Dialogues in clinical neuroscience* 2008;10(3):329-36. [published Online First: 2008/11/05]

37. Cole MG, Dendukuri N. Risk factors for depression among elderly community subjects: A systematic review and meta-analysis. *American Journal of Psychiatry* 2003;160:1147-56. doi: 10.1176/appi.ajp.160.6.1147 [published Online First: 2003/06/05]

38. Conti CL, Barbosa WM, Simão JBP, et al. Pesticide exposure, tobacco use, poor self-perceived health and presence of chronic disease are determinants of depressive symptoms among coffee growers from Southeast Brazil. *Psychiatry Res* 2018;260:187-92. doi: 10.1016/j.psychres.2017.11.063 [published Online First: 2017/12/01]

39. Leão T, Perelman J. Depression symptoms as mediators of inequalities in self-reported health: the case of Southern European elderly. *J Public Health (Oxf)* 2018;40(4):756-63. doi: 10.1093/pubmed/fdx173

40. Alarcão V, Madeira T, Peixoto-Plácido C, et al. Gender differences in psychosocial determinants of self-perceived health among Portuguese older adults in nursing homes. *Aging Ment Health* 2018:1-8. doi: 10.1080/13607863.2018.1471583 [published Online First: 2018/05/23]

41. Sonikian M, Metaxaki P, Papavasileiou D, et al. Effects of interleukin-6 on depression risk in dialysis patients. *American journal of nephrology* 2010;31:303-08. doi: 10.1159/000285110 [published Online First: 2010/02/18]

42. Nouwen A, Winkley K, Twisk J, et al. Type 2 diabetes mellitus as a risk factor for the onset of depression: A systematic review and meta-analysis. *Diabetologia* 2010;53:2480-86. doi: 10.1007/s00125-010-1874-x [published Online First: 2010/08/17]

43. Anderson RJ, Freedland KE, Clouse RE, et al. The prevalence of comorbid depression in adults with diabetes: A meta-analysis. *Diabetes care* 2001;24(6):1069-78. [published Online First: 2001/05/26]

44. Palmer S, Vecchio M, Craig JC, et al. Prevalence of depression in chronic kidney disease: Systematic review and meta-analysis of observational studies. *Kidney international* 2013;84:179-91. doi: 10.1038/ki.2013.77 [published Online First: 2013/03/15]

45. Roy T, Lloyd CE. Epidemiology of depression and diabetes: A systematic review. *Journal of affective disorders* 2012;142 Suppl:S8-S21. doi: 10.1016/s0165-0327(12)70004-6 [published Online First: 2012/10/25]

46. Atlantis E, Baker M. Obesity effects on depression: Systematic review of epidemiological studies. *International journal of obesity (2005)* 2008;32:881-91. doi: 10.1038/ijo.2008.54 [published Online First: 2008/04/17]

47. de Wit L, Luppino F, van Straten A, et al. Depression and obesity: A meta-analysis of community-based studies. *Psychiatry research* 2010;178:230-35. doi: 10.1016/j.psychres.2009.04.015 [published Online First: 2010/05/14]

48. Luppino FS, de Wit LM, Bouvy PF, et al. Overweight, obesity, and depression: A systematic review and meta-analysis of longitudinal studies. *Archives of general psychiatry*

2010;67:220-29. doi: 10.1001/archgenpsychiatry.2010.2 [published Online First: 2010/03/03]

49. Lee S, Tsang A, Huang YQ, et al. The epidemiology of depression in metropolitan China. *Psychol Med* 2009;39(5):735-47. doi: 10.1017/S0033291708004091 [published Online First: 2008/08/20]

50. Charlson FJ, Baxter AJ, Cheng HG, et al. The burden of mental, neurological, and substance use disorders in China and India: a systematic analysis of community representative epidemiological studies. *Lancet* 2016 doi: 10.1016/S0140-6736(16)30590-6

51. Wang T, Xiao S, Yang C, et al. Prevalence and incidence of depression disorder and cognitive impairment in the elderly in Shanghai, China. *Alzheimer's & Dementia* 2015;11(7):P832-P33.

52. Li J, Cacchione PZ, Hodgson N, et al. Afternoon napping and cognition in Chinese older adults: Findings from the China Health and Retirement Longitudinal Study Baseline Assessment. *Journal of American Geriatrics Society* 2017;65:373-80. doi: 10.1111/jgs.14368 [published Online First: 2016/12/21]

53. Avasthi A, Grover S. Clinical practice guidelines for management of depression in elderly. *Indian journal of psychiatry* 2018;60:S341-S62. doi: 10.4103/0019-5545.224474 [published Online First: 2018/03/15]

54. Zhang Y, Ting RZ, Yang W, et al. Depression in Chinese patients with type 2 diabetes: Associations with hyperglycemia, hypoglycemia, and poor treatment adherence. *Journal of diabetes* 2015;7:800-8008. doi: 10.1111/1753-0407.12238 [published Online First: 2014/10/29]

55. Fischer MJ, Kimmel PL, Greene T, et al. Elevated depressive affect is associated with adverse cardiovascular outcomes among African Americans with chronic kidney disease. *Kidney international* 2011;80:670-78. doi: 10.1038/ki.2011.153 [published Online First: 2011/06/03]

Tables

Table 1. Baseline characteristics of the CHARLS participants free of depressive symptoms

Variable	Distribution
N	10,288
age, years, mean (SD)	58.5 (9.8)
Male, n (%)	5845 (50.7%)
Living in rural areas, n (%)	8,440 (73.3%)
Education, n (%)	
No formal education or illiterate	2,736 (23.7%)
Some primary school	1,804 (15.7%)
Finished primary school	2,590 (22.5%)
Junior high school or above	4,394 (38.1%)
Currently married, n (%)	10,375 (90.0%)
Smoking status, n (%)	
Current smoker	3,629 (31.5%)
Former smoker	1,034 (9.0%)
Never smoking	6,868 (60.0%)
Drinking status, n (%)	
Regular drinkers	1,951 (17.9%)
Occasional drinkers	476 (4.4%)
Former drinkers	646 (5.9%)
Never drinking	7,833 (71.8%)
Weight, kg, mean (SD)	60 (11.8)
Height, m, mean (SD)	1.6 (0.1)
Body mass index, kg/m^2, mean (SD)	23.7 (4)
Sleeping duration, hours, mean (SD)	6.7 (1.7)
CES-D short form score	5.1 (3.3)
Self-perceived health status, n (%)	
Excellent	483 (4.2%)
Very good	1,744 (15.1%)
Good	4,136 (35.9%)
Fair	3,977 (34.5%)
Poor	1,187 (10.3%)
Chronic conditions, n (%)	
Hypertension	4,045 (40.3%)
Dyslipidemia	1,016 (9.0%)
Diabetes	1,210 (15.0%)
Cancer	97 (0.8%)
Liver disease	387 (3.4%)
Heart disease	1,162 (10.1%)
Stroke	188 (1.6%)
Kidney disease	563 (4.9%)

Gastrointestinal disease	2,180 (18.9%)
Dementia	105 (0.9%)
Arthritis	3,221 (28.0%)
Asthma	312 (2.7%)

Note. CES-D=Center for Epidemiologic Study of Depression short form; SD=standard deviation.

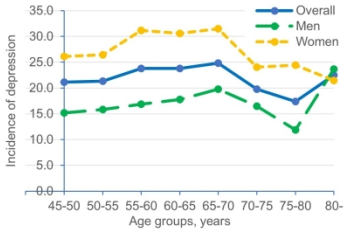
Table 2. Incidence of depressive symptoms among the CHARLS participants

	Ever having depressive Symptoms	Depressive symptoms in both visits 2 & 3	Depressive symptoms in 2 years	Depressive symptoms in 4 years
Overall	22.3 (21.3-23.3)	4.4 (4.0-4.9)	13.2 (12.5-14.1)	16.8 (15.9-17.7)
Rural	25.7 (24.6-26.8)	5.3 (4.8-5.8)	15.3 (14.3-16.2)	18.8 (17.8-19.8)
Urban	15.3 (13.4-17.2)	2.6 (1.9-3.3)	9.0 (7.4-10.6)	12.2 (10.4-14.1)
Men	16.7 (15.5-17.9)	3.0 (2.5-3.5)	9.9 (9.0-10.9)	12.2 (11.1-13.2)
Women	27.9 (26.4-29.4)	5.8 (5.1-6.6)	16.6 (15.3-17.9)	21.5 (20.1-22.9)

Table 3. Raw and multi-variates adjusted associations with the incidence of depressive symptoms in 4 years of follow-up.

	Multi-Variate Adjusted		*Raw Association*	
Variables	OR (95% CI)	P	OR (95% CI)	*P*
Age, per year older	0.99 (0.98-0.99)	**0.001**	0.99 (0.99-1.00)	0.59
Male vs. Female	0.60 (0.51-0.71)	**<.0001**	0.51 (0.46-0.56)	**<.0001**
Education level				
No formal education or illiterate	ref.	**<.0001**	ref.	**<.0001**
Some primary school	1.06 (0.90-1.25)		0.93 (0.80-1.08)	
Finished primary school	0.83 (0.71-0.97)		0.67 (0.57-0.77)	
Junior high school or above	0.71 (0.61-0.84)		0.48 (0.42-0.55)	
Rural vs. Urban	1.61 (1.38-1.88)	**<.0001**	1.72 (1.50-1.96)	**<.0001**
Not married vs Married	1.25 (1.04-1.51)	**0.02**	1.28 (1.08-1.51)	**0.004**
Smoking status				
Non-smokers	ref.		ref.	
Current smokers	1.02 (0.86-1.20)	**0.03**	0.51 (0.41-0.62)	**<.0001**
Former smokers	0.75 (0.59-0.96)		0.68 (0.60-0.76)	
Drinking status				
Never drinkers	Ref.		ref.	
Former drinkers	1.02 (0.80-1.30)	0.15	0.84 (0.67-1.04)	**<.0001**
Occasional drinkers	0.79 (0.59-1.06)		0.59 (0.45-0.78)	
Regular drinkers	0.85 (0.71-1.01)		0.59 (0.51-0.68)	
Body mass index, per 1 kg/m^2 increase	0.99 (0.98-1.01)	0.20	0.99 (0.98-1.00)	0.14
Self-perceived health status				
Excellent	0.36 (0.25-0.52)	**<.0001**	0.28 (0.20-0.39)	**<.0001**
Very good	0.36 (0.29-0.45)		0.28 (0.23-0.35)	
Good	0.53 (0.44-0.63)		0.45 (0.38-0.53)	
Fair	0.61 (0.52-0.73)		0.56 (0.48-0.66)	
Poor	ref.		ref.	
Sleep duration, per hour longer	0.89 (0.87-0.92)	**<.0001**	0.88 (0.85-0.90)	**<.0001**
Hypertension (Y vs. N)	1.07 (0.95-1.21)	0.25	1.07 (0.96-1.18)	0.22
Dyslipidemia (Y vs. N)	0.85 (0.69-1.04)	0.12	0.91 (0.76-1.09)	0.29
Diabetes (Y vs. N)	1.19 (1.00-1.42)	**0.04**	1.11 (0.95-2.30)	0.19
Cancer (Y vs. N)	0.92 (0.48-1.77)	0.80	1.17 (0.65-2.12)	0.61
Chronic Lung Disease (Y vs. N)	1.18 (0.97-1.44)	0.10	1.33 (1.12-1.58)	**0.001**
Chronic Liver Disease (Y vs. N)	0.90 (0.67-1.22)	0.51	1.04 (0.79-1.37)	0.81
Heart Disease (Y vs. N)	1.06 (0.88-1.28)	0.54	1.27 (1.08-1.49)	**0.004**
Stroke (Y vs. N)	0.88 (0.56-1.39)	0.59	1.12 (0.75-1.66)	0.58
Chronic Kidney Disease (Y vs. N)	1.32 (1.04-1.67)	**0.02**	1.45 (1.16-1.80)	**0.001**
Chronic Digestive Disorders (Y vs. N)	1.15 (1.01-1.31)	**0.04**	1.43 (1.26-1.61)	**<.0001**
Psychological Disorders (Y vs. N)	1.00 (0.53-1.89)	0.99	1.44 (0.81-2.56)	0.22
Dementia (Y vs. N)	1.31 (0.72-2.38)	0.37	1.15 (0.67-1.97)	0.62
Arthritis (Y vs. N)	1.43 (1.28-1.61)	**<.0001**	1.72 (1.54-1.91)	**<.0001**
Asthma (Y vs. N)	1.25 (0.90-1.75)	0.19	1.43 (1.06-1.91)	**0.02**

Note. CI=confidence interval; OR=odds ratio



254x190mm (300 x 300 DPI)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort 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	3
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	6-7
Objectives	3	State specific objectives, including any prespecified hypotheses	7
Methods			
Study design	4	Present key elements of study design early in the paper	8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	8-9
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	8
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	9-11
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	9
Bias	9	Describe any efforts to address potential sources of bias	17
Study size	10	Explain how the study size was arrived at	8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	12
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	12
		(*b*) Describe any methods used to examine subgroups and interactions	NA
		(*c*) Explain how missing data were addressed	NA
		(*d*) If applicable, explain how loss to follow-up was addressed	NA
		(*e*) Describe any sensitivity analyses	NA
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	8
		(b) Give reasons for non-participation at each stage	NA
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	13
		(b) Indicate number of participants with missing data for each variable of interest	NA
		(c) Summarise follow-up time (eg, average and total amount)	8
Outcome data	15*	Report numbers of outcome events or summary measures over time	NA
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	11, 13-14
		(*b*) Report category boundaries when continuous variables were categorized	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	14
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	17
Generalisability	21	Discuss the generalisability (external validity) of the study results	17
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	20

*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.

BMJ Open

Incidence and risk factors of depressive symptoms in four years of follow-up among mid-aged and elderly community-dwelling Chinese adults: Findings from the China health and Retirement Longitudinal Study

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2019-029529.R4
Article Type:	Research
Date Submitted by the Author:	18-Jul-2019
Complete List of Authors:	Wen, Yue; West China Hospital, Sichuan University, Department of Gastrointestinal Surgery Liu, Chunjuan; West China Hospital, Sichuan University, Department of Gastrointestinal Surgery Liao, Jing; West China Hospital, Sichuan University, Department of Gastrointestinal Surgery Yin, Yiqiong; West China Hospital, Sichuan University, Department of Gastrointestinal Surgery Wu, Dongmei; University of Electronic Science and Technology of China, The Clinical Hospital of Chengdu Brain Science Institute, MOE Key Lab for Neuroinformation; The Fourth People's Hospital of Chengdu & Chengdu Mental Health Center, Psychiatric Research Laboratory
Primary Subject Heading:	Mental health
Secondary Subject Heading:	Epidemiology
Keywords:	depressive symptoms, incidence, mid-aged and older adults, China

Incidence and risk factors of depressive symptoms in four years of follow-up among mid-aged and elderly community-dwelling Chinese adults: Findings from the China Health and Retirement Longitudinal Study

Yue Wen, Chunjuan Liu, Jing Liao, Yiqiong Yin*, Dongmei Wu*

Correspondence should be made to:

Dongmei Wu, PhD, RN

Department of Nursing, The Clinical Hospital of Chengdu Brain Science Institute, MOE Key Lab for Neuroinformation, University of Electronic Science and Technology of China

Huli West 1st Lane, Chengdu, Sichuan Province, China, 610036.

Tel: 86-28-69515754

E-mail: wudongmei_2001@163.com

Yiqiong Yin, BN, RN

Chief Superintendent Nurse, Department of Gastrointestinal Surgery, West China Hospital, Sichuan University

37 Guoxue Xiang Street, Chengdu, Sichuan Province, China, 610041.

Tel: 86-28-85422877

E-mail: yiqiong489@163.com

*: Yiqiong Yin and Dongmei Wu were co-corresponding authors for this manuscript.

The full names, institutions, city, and country of all other co-authors:

Yue Wen, BN, RN

Supervisor Nurse, Department of Gastrointestinal Surgery, West China Hospital, Sichuan University

37 Guoxue Xiang Street, Chengdu, China, 610041. E-mail: wenyue19820327@163.com

Chunjuan Liu, BN, RN

Supervisor Nurse, Department of Gastrointestinal Surgery, West China Hospital, Sichuan University

37 Guoxue Xiang Street, Chengdu, China, 610041. E-mail: liuchunjuan2002@163.com

Jing Liao, MSN, RN

Senior Nurse, Department of Gastrointestinal Surgery, West China Hospital, Sichuan University

37 Guoxue Xiang Street, Chengdu, China, 610041. E-mail: m15982277765@163.com

Yiqiong Yin, BN, RN

Chief Superintendent Nurse, Department of Gastrointestinal Surgery, West China Hospital, Sichuan University

37 Guoxue Xiang Street, Chengdu, China, 610041. E-mail: yiqiong489@163.com

Dongmei Wu, PhD, RN

Assistant Professor, Department of Nursing, The Clinical Hospital of Chengdu Brain Science Institute, MOE Key Lab for Neuroinformation, University of Electronic Science and Technology of China

Huli West 1st Lane, Chengdu, China, 610036. Tel: 86-28-69515754. E-mail: wudongmei_2001@163.com

Word count: 7802

Abstract

Objectives. The purpose of this study was to examine the incidence of depressive symptoms, and determine if baseline risk factors conferred a risk for incident depressive symptoms in nationally representative sample of mid-aged and elderly Chinese adults.

Design. This study was a secondary analysis of a prospective cohort from a nationally representative sample.

Setting. Community samples were recruited from the baseline survey of the China Health and Retirement Longitudinal Study. A four-stage, stratified, cluster probability sampling strategy was used, which included 10,257 households with members aged 45 years or older and their spouse.

Participants. A total of 11,533 participants free of depressive symptoms at baseline were identified, and 10,288 were re-examined in either the first and/or the second follow-up surveys. The current analysis was conducted among the 10,288 participants.

Primary and secondary outcome measures. Depressive symptoms were measured by the Center for Epidemiological Studies Depression Scale short form.

Results. The findings showed that the incidence of depressive symptoms in a 4-year follow-up was as high as 22.3%. The incidence was much higher in rural areas (25.7%) and in women (27.9%). Furthermore, participants with one-hour longer of nighttime sleep had a 10% lower risk of developing depressive symptoms. Compared to individuals who perceived their health status as poor, those who perceived their health status as excellent had a 62% lower risk of developing depressive symptoms. In addition, having diabetes (OR=1.19), chronic kidney disease (OR=1.32), chronic digestive disorders (OR=1.15), and arthritis (OR=1.43) at baseline increased the risk of depressive symptoms. However, baseline body mass index was not associated with the subsequent depressive symptoms in this population.

Conclusions. This study highlights the importance of developing an appropriate screening test to identify depressive symptoms for those who are vulnerable and ensure these individuals can receive early interventions for depressive symptoms.

Key words: depressive symptoms, incidence, mid-aged and older adults, China

Strengths and limitations of this study

- Since the sample was representative of community-dwelling mid-aged and older Chinese adults, the study results can be generalized to mid-aged and older Chinese adults.
- Depressive symptoms were based on self-reports instead of clinical diagnosis. Therefore, information bias may be present. However, with a longitudinal design, information bias in the current study was likely to be non-differential.
- This study was a prospective analysis of baseline risk factors of depressive symptoms at follow-up, and no causal associations between these predictors and depressive symptoms can be drawn from the analysis.

Introduction

Depression has been recognized as a leading cause of disability and a major contributor to disease burdens globally [1]. An estimated 322 million adults had depression in 2015 worldwide, with nearly half of these people living in the South-East Asia and Western Pacific regions [2]. In China, about 4.2% adults was estimated to be depressed, and the prevalence of depression reached a peak in older adulthood [2]. With fast economic growth, mid-aged adults are exposed to a high-stress lifestyle, which is thought to contribute significantly to an increase in mental health disorders in susceptible people [1]. Older adults, on the other hand, face noteworthy challenges to their life, including loss of independence, loss of social support due to the death of a spouse or weakened family connectedness (traditionally referred to as 'filial piety'), financial difficulties, and medical vulnerability [3]. Late-life depressive symptoms increase risk for significant impairment in social function [3], dementia [4], declined quality of life [5], and suicide [6]. They further complicate the prognosis of concurrent medical problems by increasing physical disability and decreasing motivation and adherence to prescribed medications and/or exercise or rehabilitation programs [7 8].

Although depression has come to be regarded as the common cold of psychosocial functioning in Western culture, mental disorders are still viewed as degrading not only to the patient, but also to the entire family in Chinese culture [9 10]. In addition, although effective interventions have been developed to alleviate symptoms of depression, depressive symptoms are often overlooked among the elderly, since most of them mistakenly consider these symptoms to be part of the normal aging process [11]. Therefore, older adults may not actively seek medical treatment and leave their depressive symptoms undiagnosed or untreated. As persons aged 45 or older will increase from 32% to 51% of the total population from 2010 to 2040 in China [12],

reliable and up-to-date estimates of the proportion of this population affected by depressive symptoms are a key ingredient of effective health policy, planning, and evaluations.

Recently, a number of population-based studies have estimated the prevalence of depressive symptoms among mid-aged and older Chinese adults [3 11 13 14]. Given that all these studies were cross-sectional, the incidence of depressive symptoms among mid-aged and older Chinese adults was not clear. Furthermore, despite a myriad of studies that examined a number of health conditions associated with an increased risk of mid- and late-life depressive symptoms, including chronic diseases, overweight/obesity, sleep duration, and self-perceived health status [3 14-17], the prospective relationships between these health conditions and depressive symptoms have not been well understood in this population. Such prospective relationships may provide further evidence on how baseline conditions may be predictive of depressive symptoms in the follow-up periods than cross-sectional analysis, especially given that these health conditions are expected to be a great challenge to an increasing aging population, and can often co-occur with depressive symptoms which may make these conditions even worse [3]. A better understanding of these associations may also provide information that is useful in identifying patients who are vulnerable to mid-life or late-life depressive symptoms, and proactively assessing and treating modifiable risk factors during primary health care service.

Therefore, the purpose of this study was to examine the incidence of depressive symptoms among mid-aged and older adults in China, and determine if baseline sleep duration, body weight, self-perceived health status, and chronic conditions conferred a risk for incident depressive symptoms over time, using baseline and four years of follow-up data from the China Health and Retirement Longitudinal Study (CHARLS).

Methods

Study Design

This study was a secondary analysis of prospective data from the CHARLS. The CHARLS is a nationwide, community-engaged, population-based epidemiological study of Chinese adults aged 45 years or older. The purpose of the CHARLS was to obtain detailed information regarding the dynamics of retirement and how it interacts with health, health insurance, and economic well-being. The CHARLS collects detailed information on a wide range of domains, including demographics, health status, physical measures, employment history, pension insurance, retirement, income, expenditures and assets [18]. The current study used data from baseline, the first, and the second follow-up surveys.

Participants

The CHARLS national baseline survey was conducted in 28 provinces (Tibet, Ningxia, and Hainan were not included) across the country from May 2011 to March 2012. It was a survey of 10,257 households with members aged 45 years or older and their spouse, for a total of about 17,708 individuals. A four-stage, stratified, cluster probability sampling strategy was used to select eligible participants [18]. Details of the sampling procedures have been published elsewhere [19]. In brief, in the first stage, all counties were grouped by gross domestic product and by urban or rural regions. In the second stage, counties were stratified and sampled using probabilities proportional to size (PPS). Three rural villages and urban neighborhoods were randomly selected as primary sampling units (PSUs) using PPS in each county. In the third stage, all buildings in each PSU were recognized on satellite imagery of the Google Earth. A sample of 24 households was randomly selected among all households in each PSU. In the final stage, a short screening form was employed to ensure study eligibility in selected households and

members of 45 years of age or above were invited to enroll into the study. The response rate for the survey was over 80% (94% in rural areas and 69% in urban areas) [18].

The baseline cohort of the CHARLS participants was followed up every two years with the same survey questionnaires and biomedical measures [18]. The first follow-up survey of the CHARLS was fielded between July 2013 and January 2014. Subjects in this study used the same inclusion and exclusion criteria as the original study. A total of 11,533 participants free of depressive symptoms at baseline was identified, of whom 9,329 participated in the first follow-up survey in 2013-2014, 9,157 were examined in the second follow-up survey in 2015-2016, and 10,288 were followed in either the first or the second follow-up surveys. The current analysis was conducted among the 10,288 participants.

Patient and Public Involvement

In the current study, we used de-identified data from the CHARLS with no direct involvement of or interaction with participants in the design, recruitment or conduct of the original cohort study.

Variables, Definitions, and Measures

Depressive symptoms. The Center for Epidemiological Studies Depression Scale (CES-D) short form was used to measure depressive symptoms [20]. The CES-D short form consists of ten items, and each item is rated on a four-point Likert scale with answers ranging from 0 (rarely or none of the time) to 3 (most or all of the time) and the total possible summary score of 0 to 30. The time frame for the CES-D short form refers to the week prior to the interview. Item 5 ("feeling hopeful about the future") and 8 ("feeling happy") are reversely scored before analysis. Higher scores corresponds to higher levels of depressive symptoms, and a score of 12 or higher has been used as the cut-off point for depressive symptoms [21].

The CES-D short form has been validated among a subsample of 742 CHARLS participants aged 60 years and older, demonstrating adequate psychometric properties [21]. Two factors were identified by confirmatory factor analysis. Somatic retardation and depressive affect were identified as the first factor, and positive affect was identified as the second factor. The two-factor structure varied across both genders in multi-group analysis (χ^2= 144.13, p<0.001). R^2 coefficient was used to measure the reliability of each item, with some of items differing between men and women. For example, depressive affect and somatic retardation explained 37% and 64% of the variance in the depression indicator ("bothered") for men and women, respectively [21].

Measure of health conditions associated with depressive symptoms. These factors included chronic conditions, overweight/obesity, sleep duration, and self-perceived health status. Information on chronic conditions was primarily based on self-reports except hypertension and diabetes. Participants were asked if they had been diagnosed with any of the following health conditions: arthritis, dyslipidemia, cancer (excluding minor skin cancers), liver diseases (except for fatty liver, tumors or cancer), cardiovascular diseases (heart attack, coronary heart disease, angina, congestive heart failure, or other heart problems), stoke, kidney disease (except for cancer or tumor), stomach or other gastrointestinal diseases (except for tumor or cancer), memory-related diseases, and asthma. Participants answered "yes" to these questions were defined as having these conditions.

Hypertension was defined based on the most current guidelines from the American Heart Association, which have lowered the threshold of hypertension cut-off points to 130/80 mmHg [22]. A systolic blood pressure measurement of 130 mmHg and higher, or a diastolic measurement of 80 mmHg and higher, or 130/80 mmHg and higher, or taking antihypertensive medications

including modern western medicine, traditional Chinese medicine, or using other treatment options for hypertension was considered as having hypertension [22]. Blood pressure was measured three times (approximately 45 seconds apart) for each participant on the left arm in a sitting position, using an electronic blood pressure monitor (Omron™ HEM-7112) [23].

The diagnosis of diabetes was based on the current guidelines from the American Diabetes Association [24]. A reading of 126 mg/dL or higher for fasting blood glucose, or a reading of 200 mg/dL or higher for random blood glucose, or a reading of 6.5% or higher for glycated hemoglobin, or use of insulin, or taking oral hypoglycemic medications including traditional Chinese medicine, modern western medicine, or other diabetes treatment was considered as having diabetes [24].

Weight was measured to the nearest 0.1 kg using a digital scale (Omron™ HN-286, Yangzhou, China) on an even, uncarpeted surface, with participants removing heavy outer clothing. Height was measured without shoes to the nearest 0.1 cm using a stadiometer (Seca™213, Hangzhou, China). Body mass index (BMI, weight in kilograms divided by height in meters squared) was calculated from the participants' weight and height.

Self-perceived health status was measured based on self-reports to the following question, "Would you rate health as…", with five response options provided: excellent, very good, good, fair, and poor.

Nighttime sleep duration in hours was collected using a question, "During the past month, how many hours of actual sleep did you get at night (average hours for one night)? (This may be shorter than the number of hours you spend in bed.)"

Covariates. Factors that could confound the main association were identified a priori from current literature. Covariates included age, gender [3], education [25], and marital status [3 26].

Consistent with a prior CHARLS publications [27 28], education was categorized as illiterate or no formal education, some primary school but can read and write, primary school including home schooling, and middle school or above. Marital status was grouped as married versus not married.

Ethical Considerations

The CHARLS was approved by the Peking University Ethical Review Committee. The current study is a secondary analysis of the de-identified CHARLS public data. The Ethics Review Committee granted an exempt research determination to the current study.

Statistical Analysis

Incidence of depressive symptoms. The incidence of depressive symptoms was analyzed taking into account the complex survey design and nonresponse rate in both estimates and the corresponding standard errors. Participants were categorized into 5-year age groups. SAS PROC SURVEYFREQ procedure was used to obtain overall and gender-specific incidence of depressive symptoms among all participants and by the 5-year age groups. In addition, overall and gender-specific incidence of depressive symptoms was estimated by rural and urban areas. We estimated the incidence of four outcomes of depressive symptoms: having depressive symptoms in the first follow-up survey (2013-2014); having depressive symptoms in the second follow-up survey (2015-2016); ever having depressive symptoms in the first or the second follow-up survey; and consistently having depressive symptoms in both follow-up surveys.

Prospective analysis. Baseline characteristics of the participants were summarized as frequency and percentage for categorical variables and mean and standard deviation or median and interquartile range for continuous variables. Associations of baseline health conditions, including chronic conditions, overweight/obesity, sleep duration, and self-perceived health status, with the incidence of ever having depressive symptoms in 4 years of follow-up were evaluated

by a multivariate logistic regression model, while controlling for all covariates as mentioned above. Odds ratios (ORs) and the corresponding 95% confidence intervals (CIs) were reported. The SAS 9.4 (SAS Institute Inc., Cary, North Carolina) was used to perform the analyses. All the p values were two-sided, and $p<0.05$ was considered significant.

Results

Sample Characteristics

A total of 10,288 participants aged 45 years or older was included in the analysis. As shown in Table 1, the average age of all participants was 58.5 years and roughly half participants (49.3%) were women. Most of participants (73.3%) lived in rural areas and 60.6% participants had primary education or above. The majority of participants (90.0%) were married or living with a partner at the time of data collection. About a third of the participants (31.5%) were current smokers and 17.9% were current regular drinkers. Participants had an average BMI of 23.7 kg/m^2. The mean duration of sleep per night was 6.7 hours, and less than 20% of participants perceived their health status as very good or excellent. The mean CES-D short form score was 5.1 at baseline.

Incidence of Depressive Symptoms

As shown in Table 2 and in Figure 1, the incidence of ever having depressive symptoms in 4 years was 22.3% (95% CI: 21.3%-23.3%). The incidence was much higher in rural areas than that in urban areas (25.7% vs. 15.3%, $p<.0001$). Women had a higher incidence of depressive symptoms than men (27.9% vs. 16.7%, $p<.0001$). There is no clear pattern of the incidence of depressive symptoms over age groups (Figure 1). The incidence was highest among the 65-70 years of age group and lowest among the 45-50 years of age group.

Baseline Risk Factors and Incident Depressive Symptoms

As shown in Table 3, in the fully adjusted multivariable logistic regression model, nighttime sleep duration and self-perceived health status were both inversely associated with the risk of depressive symptoms. Specifically, participants with one-hour longer of nighttime sleep had a 10% (95% CI: 7%-13%, p<.0001) lower risk of developing depressive symptoms in 4 years of follow up. Compared to individuals who perceived their health status as poor, those who perceived their health status as fair, good, very good, and excellent had a 42% (95% CI: 39%-52%), 47% (95% CI: 36%-57%), 64% (95% CI: 54%-72%), and 62% (95% CI: 43%-74%) lower risk of developing depressive symptoms, respectively. In addition, four chronic conditions, including diabetes (OR=1.19, 95% CI: 1.00-1.42, p=.04), chronic kidney disease (OR=1.32, 95% CI: 1.04-1.67, p=.02), chronic digestive disorders (OR=1.15, 95% CI: 1.01-1.31, p=.04), and arthritis (OR=1.43, 95% CI: 1.28-1.61, p<.0001), were associated with higher risk of depressive symptoms. However, baseline BMI was not associated with the onset of depressive symptoms in this population (OR=0.99, 95% CI: 0.97-1.01). Chronic lung disease (p=.001), heart disease (p=.004), and asthma (p=.02) were positively associated with incidence of depressive symptoms in the raw analysis, but became non-significant in the fully adjusted model (all p>.05).

Discussion

Through the analysis of data from a nationally representative sample of mid-aged and older Chinese adults, we found that the incidence of depressive symptoms in a 4-year follow-up was as high as 22.3%. Large disparities in the incidence of depressive symptoms were observed between rural and urban areas and between men and women. Furthermore, longer nighttime sleep duration and better self-perceived health status were both associated with lower risk of depressive symptoms. In addition, diabetes, chronic kidney disease, chronic digestive disorders,

and arthritis at baseline increased the risk of depressive symptoms. However, baseline BMI was not associated with depressive symptoms in this population.

Our study found that in four years of follow-up, about 22.3% of the mid-aged and older Chinese adults developed depressive symptoms. Using the same database, a recent study reported that the prevalence of depressive symptoms at CHARLS baseline survey was up to 26.2% [13]. Collectively, these findings revealed that depressive symptoms were a major public health challenge in China, and intervention programs should be developed to reduce the burden of depressive symptoms. Furthermore, large disparities were also observed between rural and urban residents and between men and women. In particular, women and residents living in rural areas were at a higher risk of developing depressive symptoms. The high incidence rate was not only relevant to mid-aged and older Chinese adults, but also had implications for young children's developmental outcomes. Many depressive symptoms cases remained undiagnosed, and even among those who were aware of the condition, few of them sought treatment due to cultural stigma [9 10] . Mid-aged and elderly grandparents are the primary caregivers of infants, toddlers, and young children in rural China. Depressed caregivers were more likely to show negative parenting interactions (e.g., limited facial and behavioral affect) with their children, and these interactions were directly relevant for children's development [29 30]. A strong negative correlation has been reported between the levels of depression of grandmothers and the levels of developmental outcomes of the grandchildren in their care, including cognitive, language, social-emotional, and motor functions [31 32]. Taken together, changes in social policies and intervention programs should be developed to address timely diagnosis and treatment of depression for these people, which will help improve young children's developmental outcomes in rural China.

Individuals with longer nighttime sleep duration had a lower risk of depressive symptoms. This finding is in line with previous studies [33 34]. Sleep disorders are often the presenting and core symptoms of depression [35]. However, treatment of depression did not resolve sleep symptoms, which may confer a greater risk for depression recurrence and relapse [35]. Therefore, sleep deprivation should be at least considered as an early indicator of depressive symptoms. Individuals with sleep deprivation should be aware of their high risk of depressive symptoms and increase nighttime sleep duration.

Better self-perceived health status at baseline was associated with a lower risk of depressive symptoms in the current study. The finding is consistent with studies among other populations [36 37]. Self-perceived health is a powerful indicator of the overall health status of elderly people [38]. Many factors, including sociodemographic characteristics, chronic diseases, functional status, social relationships, neighborhood environment, and nutrition pattern, are all important determinants of self-perceived health status [38]. These factors are also associated with depressive symptoms. The current study adjusted most of the factors, except for functional status, social relationship, and nutrition pattern, which were not available in the CHARLS database. However, poorer self-perceived health status was still significantly associated with a higher risk of depressive symptoms. Future studies additionally controlling for those factors will help evaluate the contribution of those factors to the association of self-perceived health status with depressive symptoms. Furthermore, such study may also help delineate whether self-perceived health status may represent other factors that may lead to depressive symptoms. Finally, previous studies also found that individuals with depressive disorders were more likely to report poor self-perceived health status [39 40]. Therefore, there might be a bidirectional association between

depressive symptoms and self-perceived health status. Future studies examining the bidirectional relationship are therefore needed.

Among 12 chronic conditions, baseline chronic kidney disease increased the risk of depressive symptoms at follow-up. Although the underlying mechanisms have not been well understood, some authors suggested that the psychosocial and biologic changes in dialysis may explain this relationship [41]. In addition to chronic kidney disease, baseline diabetes also conferred a higher risk of symptoms of depression over time in this study. Similar results were reported in a meta-analysis of 11 studies, which found that people with diabetes at baseline had a 24% higher risk of developing depression at follow-up compared to those without diabetes [42]. Furthermore, a high prevalence of depression among people with diabetes and/or chronic kidney disease has also been reported in cross-sectional studies [43-45]. In concordance with these findings, this study added further evidence that compared to other chronic conditions at baseline, baseline chronic kidney disease and diabetes were more likely to be associated with depressive symptoms over time in a population of mid-aged and older Chinese adults.

Consistent with our study, a growing body of evidence reveals a high prevalence and incidence of depression among people with arthritis. For example, in a recent meta-analysis, the prevalence of major depressive disorder among patients with rheumatoid arthritis was 17% [46]. In a population-based cohort in Taiwan, patients with rheumatoid arthritis were 2.06 times more likely to develop depression compared with the control patients [47]. The high prevalence and incidence of depression among patients with arthritis may be attributed to several factors, including the impact of the diagnosis with no cure, arthritis symptoms and flare-ups, loss of work productivity, and side effects of medications [48]. In the current study, we found that chronic digestive disorders at baseline conferred a higher risk for depressive symptoms over time. In line

with this finding, using the National Health Insurance Research Database in Taiwan, Lee et al. found that irritable bowel syndrome was a risk factor for subsequent depressive and anxiety disorders [49]. The digestive system is sensitive to the impact of emotional factors, because the function of digestive system is jointly controlled by the endocrine system and vegetative nervous system, and the center of both systems is located at the same place as the center of emotion [50].

Overweight/obesity is well established to interfere with mental health, with depressive symptoms being more common among overweight/obese individuals than their normal-weight counterparts, especially in overweight/obese women [51 52]. This relationship was further confirmed by a meta-analysis of longitudinal studies, in which excess weight at baseline increased a higher risk for subsequent depression at follow-up [53]. In contrast to these findings from Western and European countries, using data from a prospective survey of a large, representative sample of mid-aged and elderly community-dwelling residents in Mainland China, we did not find a relationship between baseline BMI and subsequent depressive symptoms over time. These inconsistent findings may suggest that because participants in the current study were predominantly low in BMI at baseline (mean baseline BMI was 23.7 kg/m^2), their likelihood of experiencing depressive symptoms may have been lower compared to those participants reported in Luppino et al [53]. However, these are preliminary findings that need to be further investigated in future prospective studies in this population.

The study has several important strengths. First, to the best of our knowledge, this is the first study that examined the incidence of depressive symptoms in a nationally representative population in China. As noted above, previous studies have primarily focused on the prevalence of depressive symptoms [3 11 13 14] or investigated the incidence of depressive symptoms in a regional sample [54]. Second, since the sample was representative of community-dwelling mid-

aged and older Chinese adults, the results can be generalized to mid-aged and older Chinese adults. Third, a Chinese specific cut-off point of the CES-D short form has been used, and the cut-off point was validated among mid-aged and older Chinese adults [21]. Therefore, our study provided a more reliable estimate of the incidence of depressive symptoms. Finally, strict quality control measures, including GPS matching, data checking, recording and checking interviews, and calling back participants, were implemented at each stage of the CHARLS to ensure high quality data.

There are also some limitations in this study that should be acknowledged. First, depressive symptoms were based on self-reports instead of clinical diagnosis. Therefore, information bias may be present. However, with a longitudinal design, information bias in the current study was likely to be non-differential. Since non-differential misclassification generally affects the association estimates towards the null, our study findings were more robust. Second, nighttime sleep duration was measured based on self-reports. The use of self-report measures in the CHARLS surveys may have biased study results, since participants may consistently under- or overestimate their nighttime sleep duration [55]. Objective or direct measures of sleep duration should be used to increase precision and accuracy of self-report assessment methods. Finally, this study was a prospective analysis of baseline risk factors of depressive symptoms at follow-up, and no causal associations between these predictors and depressive symptoms can be drawn from the analysis.

The findings of the current study have important implications for clinical practice. Health care professionals are encouraged to address the needs for better mental health in older adults [56]. In view of the high incidence of depressive symptoms (22.3%) among mid-aged and elderly Chinese adults, the findings of this study highlight the importance of developing an appropriate

screening test to identify depressive symptoms for those who are vulnerable and ensure these individuals can receive early interventions for depressive symptoms. The screening test should include items such as areas of living (rural or urban areas), gender, nighttime sleep duration, self-perceived health status, and certain chronic conditions, especially chronic kidney disease, diabetes, arthritis, and chronic digestive disorders. In addition, intervention strategies that address short nighttime sleep duration may be used to alleviate depressive symptoms and improve mental health in this population. Intervention programs should also be prioritized to target at specific populations, such as women and residents living in rural areas, as these populations were at a higher risk of developing depressive symptoms. Finally, new patients with chronic kidney disease, diabetes, arthritis, or chronic digestive disorders should be screened for depressive symptoms using the CES-D short form at the initial visit. Persons with depressive symptoms (a score of 12 or higher) should then be assessed by a clinician using the structured clinical interview for Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition. Potential participants with serious depressive symptoms should be referred immediately to a mental health professional. Individuals with these chronic conditions are particularly vulnerable to the deleterious effects of affective symptoms, since symptoms of depression is a known risk factor for noncompliance with medical treatment and adverse health outcomes [48 49 57 58].

Conclusions

To conclude, our study found a high incidence of depressive symptoms in 4 years of follow-up among a nationally representative mid-aged and older Chinese population. In addition, great disparities in the incidence of depressive symptoms were observed between individuals living in rural and urban areas and between men and women. Furthermore, we identified that worse self-perceived health, shorter nighttime sleep duration, diabetes, chronic kidney disease,

chronic digestive disorders, and arthritis at baseline increased the risk for depressive symptoms. These findings supported the importance of baseline status to longitudinal changes in depressive symptoms. Interventions for vulnerable mid-aged and older adults should focus on addressing short nighttime sleep duration. These findings also help identify individuals at a higher risk for depressive symptoms, such as those with chronic kidney disease, chronic digestive disorders, arthritis, and diabetes, or women and residents living in rural areas, so that early interventions can be implemented to prevent depressive symptoms in these people.

Figure Legend

Figure 1. The Incidence of Depressive Symptoms in 4 Years of Follow-up among Participants of the CHARLS

Contributorship Statement

All authors contribute to the conception and design of this study. YW, YY, and DW were responsible for the design, analysis, drafting and revision of this manuscript. CL and JL were responsible for interpretation of data and preparation of the manuscript.

Competing Interests Statement

None declared.

Funding Statement

This work was supported by the Sichuan Science and Technology Program grant number 2018JY0306 to Dr. Dongmei Wu. The CHARLS is funded by Peking University, the National Natural Science Foundation of China, the Behavioral and Social Research Division of the National Institute on Aging, and the World Bank.

Acknowledgments

The authors would gratefully acknowledge the assistance Dr. Tingting Liu, an assistant professor at University of Arkansas Eleanor Mann School of Nursing for editing the manuscript.

Patient Consent for Publication

Not required.

Data Sharing Statement

The study used a public data from the CHARLS that were obtained from the CHARLS home page at http://charls.pku.edu.cn/en.

References

1. Qin X, Wang S, Hsieh C. The prevalence of depression and depressive symptoms among adults in China: Estimation based on a National Household Survey. *China Economic Review* 2016 doi: 10.1016/j.chieco.2016.04.001
2. World Health Organization. Depression and other common mental disorders: Global health estimates. Geneva, Swiss: World Health Organization 2017.
3. Lei X, Sun X, Strauss J, et al. Depressive symptoms and SES among the mid-aged and elderly in China: Evidence from the China Health and Retirement Longitudinal Study national baseline. *Social Science & Medicine* 2014;120:224-32. doi: 10.1016/j.socscimed.2014.09.028 [published Online First: 2014/09/28]
4. Diniz BS, Butters MA, Albert SM, et al. Late-life depression and risk of vascular dementia and Alzheimer's disease: Systematic review and meta-analysis of community-based cohort studies. *The British journal of psychiatry : the journal of mental science* 2013;202:329-35. doi: 10.1192/bjp.bp.112.118307 [published Online First: 2013/05/03]
5. Sivertsen H, Bjørkløf GH, Engedal K, et al. Depression and quality of life in older persons: A review. *Dementia and geriatric cognitive disorders* 2015;40:311-39. doi: 10.1159/000437299
6. Wang CW, Chan CL, Yip PS. Suicide rates in China from 2002 to 2011: An update. *Social psychiatry and psychiatric epidemiology* 2014;49:929-41. doi: 10.1007/s00127-013-0789-5 [published Online First: 2013/11/19]
7. Holzapfel N, Lowe B, Wild B, et al. Self-care and depression in patients with chronic heart failure. *Heart & Lung* 2009;38:392-97. doi: 10.1016/j.hrtlng.2008.11.001 [published Online First: 2009/09/17]

8. Gonzalez JS, Safren SA, Delahanty LM, et al. Symptoms of depression prospectively predict poorer self-care in patients with type 2 diabetes. *Diabetetic Medicine* 2008;25:1102-07. doi: 10.1111/j.1464-5491.2008.02535.x [published Online First: 2009/02/03]

9. Zeng B, Sun W, Gary RA, et al. Towards a conceptual model of diabetes self-management among Chinese immigrants in the United States. *International journal of environmental research and public health* 2014;11:6727-42. doi: 10.3390/ijerph110706727 [published Online First: 2014/07/01]

10. He P, Hu Y, Li C, et al. Predictors of depressive symptoms among mid-aged and older men with diabetes in China. *Research and theory for nursing practice* 2019;33(1):6-22. doi: 10.1891/1541-6577.33.1.6 [published Online First: 2019/02/24]

11. Xu Y, Yang J, Gao J, et al. Decomposing socioeconomic inequalities in depressive symptoms among the elderly in China. *BMC public health* 2016;16:1214. doi: 10.1186/s12889-016-3876-1 [published Online First: 2016/12/03]

12. United Nations Deparment of Economic and Social Affais/Population Division. World population prospects: The 2012 revision, volume II: Demophic profiles. New York, NY: United Nations 2012.

13. Li C, Miles T, Shen L, et al. Early-life exposure to severe famine and subsequent risk of depressive symptoms in late adulthood: The China Health and Retirement Longitudinal Study. *British Journal of Psychiatry* 2018;213:579-86. doi: 10.1192/bjp.2018.116 [published Online First: 2018/08/31]

14. Yu J, Li J, Cuijpers P, et al. Prevalence and correlates of depressive symptoms in Chinese older adults: A population-based study. *International journal of geriatric psychiatry* 2012;27:305-12. doi: 10.1002/gps.2721 [published Online First: 2011/05/04]

15. Alvaro PK, Roberts RM, Harris JK. A systematic review assessing bidirectionality between sleep disturbances, anxiety, and depression. *Sleep* 2013;36:1059-68. doi: 10.5665/sleep.2810 [published Online First: 2013/07/03]

16. Wilson-Genderson M, Heid AR, Pruchno R. Onset of multiple chronic conditions and depressive symptoms: A life events perspective. *Innovation in Aging* 2017;1:igx022-igx22. doi: 10.1093/geroni/igx022

17. Qian J, Li N, Ren X. Obesity and depressive symptoms among Chinese people aged 45 and over. *Scientific reports* 2017;7:45637. doi: 10.1038/srep45637

18. Zhao Y, Hu Y, Smith JP, et al. Cohort profile: The China Health and Retirement Longitudinal Study (CHARLS). *International journal of epidemiology* 2014;43:61-68. doi: 10.1093/ije/dys203 [published Online First: 2012/12/18]

19. Li C, Liu T, Sun W, et al. Prevalence and risk factors of arthritis in a middle-aged and older Chinese population: The China Health and Retirement Longitudinal Study. *Rheumatology (Oxford, England)* 2015;54:697-706. doi: 10.1093/rheumatology/keu391 [published Online First: 2014/10/08]

20. Andresen EM, Malmgren JA, Carter WB, et al. Screening for depression in well older adults: Evaluation of a short form of the CES-D (Center for Epidemiologic Studies Depression Scale). *American journal of preventive medicine* 1994;10(2):77-84. [published Online First: 1994/03/01]

21. Chen H, Mui AC. Factorial validity of the Center for Epidemiologic Studies Depression Scale short form in older population in China. *International psychogeriatrics / IPA* 2014;26:49-57. doi: 10.1017/s1041610213001701 [published Online First: 2013/10/16]

22. Whelton PK, Carey RM, Aronow WS, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults: Executive Summary: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *Circulation* 2018;138(17):e426-e83. doi: 10.1161/cir.0000000000000597 [published Online First: 2018/10/26]

23. Zhao Y, Crimmins E, Hu P, et al. China Health And Retirement Longitudinal Study: 2011-2012 national baseline blood data users' guide. Beijing, China: China Center for Economic Research, Peking Universtiy 2014.

24. American Diabetes Association. 2. Classification and diagnosis of diabetes: Standards of medical care in diabetes-2018. *Diabetes care* 2018;41:S13-S27. doi: 10.2337/dc18-S002 [published Online First: 2017/12/10]

25. Bjelland I, Krokstad S, Mykletun A, et al. Does a higher educational level protect against anxiety and depression? The HUNT study. *Social science & medicine (1982)* 2008;66:1334-45. doi: 10.1016/j.socscimed.2007.12.019 [published Online First: 2008/02/01]

26. Cheng HG, Chen S, McBride O, et al. Prospective relationship of depressive symptoms, drinking, and tobacco smoking among middle-aged and elderly community-dwelling adults: Results from the China Health and Retirement Longitudinal Study (CHARLS). *Journal of affective disorders* 2016;195:136-43. doi: 10.1016/j.jad.2016.02.023 [published Online First: 2016/02/20]

27. Zuo M, Gan C, Liu T, et al. Physical predictors of cognitive function in individuals with hypertension: Evidence from the CHARLS basline survey. *Western journal of nursing*

research 2019;41(4):592-614. doi: 10.1177/0193945918770794 [published Online First: 2018/05/11]

28. Zhang M, Liu T, Li C, et al. Physical performance and cognitive functioning among individuals with diabetes: Findings from the China Health and Retirement Longitudinal Study Baseline Survey. *Journal of advanced nursing* 2019;75(5):1029-41. doi: 10.1111/jan.13901 [published Online First: 2018/11/07]
29. Lovejoy MC, Graczyk PA, O'Hare E, et al. Maternal depression and parenting behavior: A meta-analytic review. *Clinical psychology review* 2000;20(5):561-92. [published Online First: 2000/06/22]
30. Pelaez M, Field T, Pickens JN, et al. Disengaged and authoritarian parenting behavior of depressed mothers with their toddlers. *Infant behavior & development* 2008;31(1):145-8. doi: 10.1016/j.infbeh.2007.06.002 [published Online First: 2007/07/27]
31. Yue A, Gao J, Yang M, et al. Caregiver depression and early child development: A mixed-methods study from rural China. *Frontiers in psychology* 2018;9:2500. doi: 10.3389/fpsyg.2018.02500 [published Online First: 2019/01/09]
32. Zhang S, Dang R, Yang N, et al. Effect of caregiver's mental health on early childhood development across different rural communities in China. *International journal of environmental research and public health* 2018;15(11) doi: 10.3390/ijerph15112341 [published Online First: 2018/10/27]
33. Sun Y, Shi L, Bao Y, et al. The bidirectional relationship between sleep duration and depression in community-dwelling middle-aged and elderly individuals: Evidence from a longitudinal study. *Sleep medicine* 2018;52:221-29. doi: 10.1016/j.sleep.2018.03.011 [published Online First: 2018/06/05]

34. Li Y, Wu Y, Zhai L, et al. Longitudinal association of sleep duration with depressive symptoms among middle-aged and older Chinese. *Scientific reports* 2017;7:11794. doi: 10.1038/s41598-017-12182-0 [published Online First: 2017/09/20]

35. Nutt D, Wilson S, Paterson L. Sleep disorders as core symptoms of depression. *Dialogues in clinical neuroscience* 2008;10(3):329-36. [published Online First: 2008/11/05]

36. Cole MG, Dendukuri N. Risk factors for depression among elderly community subjects: A systematic review and meta-analysis. *American Journal of Psychiatry* 2003;160:1147-56. doi: 10.1176/appi.ajp.160.6.1147 [published Online First: 2003/06/05]

37. Conti CL, Barbosa WM, Simão JBP, et al. Pesticide exposure, tobacco use, poor self-perceived health and presence of chronic disease are determinants of depressive symptoms among coffee growers from Southeast Brazil. *Psychiatry Res* 2018;260:187-92. doi: 10.1016/j.psychres.2017.11.063 [published Online First: 2017/12/01]

38. Machón M, Vergara I, Dorronsoro M, et al. Self-perceived health in functionally independent older people: Associated factors. *BMC geriatrics* 2016;16:66. doi: 10.1186/s12877-016-0239-9 [published Online First: 2016/03/11]

39. Leão T, Perelman J. Depression symptoms as mediators of inequalities in self-reported health: the case of Southern European elderly. *J Public Health (Oxf)* 2018;40(4):756-63. doi: 10.1093/pubmed/fdx173

40. Alarcão V, Madeira T, Peixoto-Plácido C, et al. Gender differences in psychosocial determinants of self-perceived health among Portuguese older adults in nursing homes. *Aging Ment Health* 2018:1-8. doi: 10.1080/13607863.2018.1471583 [published Online First: 2018/05/23]

41. Sonikian M, Metaxaki P, Papavasileiou D, et al. Effects of interleukin-6 on depression risk in dialysis patients. *American journal of nephrology* 2010;31:303-08. doi: 10.1159/000285110 [published Online First: 2010/02/18]

42. Nouwen A, Winkley K, Twisk J, et al. Type 2 diabetes mellitus as a risk factor for the onset of depression: A systematic review and meta-analysis. *Diabetologia* 2010;53:2480-86. doi: 10.1007/s00125-010-1874-x [published Online First: 2010/08/17]

43. Anderson RJ, Freedland KE, Clouse RE, et al. The prevalence of comorbid depression in adults with diabetes: A meta-analysis. *Diabetes care* 2001;24(6):1069-78. [published Online First: 2001/05/26]

44. Palmer S, Vecchio M, Craig JC, et al. Prevalence of depression in chronic kidney disease: Systematic review and meta-analysis of observational studies. *Kidney international* 2013;84:179-91. doi: 10.1038/ki.2013.77 [published Online First: 2013/03/15]

45. Roy T, Lloyd CE. Epidemiology of depression and diabetes: A systematic review. *Journal of affective disorders* 2012;142 Suppl:S8-S21. doi: 10.1016/s0165-0327(12)70004-6 [published Online First: 2012/10/25]

46. Matcham F, Rayner L, Steer S, et al. The prevalence of depression in rheumatoid arthritis: a systematic review and meta-analysis. *Rheumatology (Oxford, England)* 2013;52(12):2136-48. doi: 10.1093/rheumatology/ket169 [published Online First: 2013/09/05]

47. Wang SL, Chang CH, Hu LY, et al. Risk of developing depressive disorders following rheumatoid arthritis: A nationwide population-based study. *PloS one* 2014;9(9):e107791. doi: 10.1371/journal.pone.0107791 [published Online First: 2014/09/17]

48. Vallerand IA, Patten SB, Barnabe C. Depression and the risk of rheumatoid arthritis. *Current Opinion in Rheumatology* 2019;31(3):279-84. doi: 10.1097/bor.0000000000000597

49. Lee YT, Hu LY, Shen CC, et al. Risk of psychiatric disorders following irritable bowel syndrome: A nationwide population-based cohort study. *PloS one* 2015;10(7):e0133283. doi: 10.1371/journal.pone.0133283 [published Online First: 2015/07/30]

50. Zipfel S, Sammet I, Rapps N, et al. Gastrointestinal disturbances in eating disorders: Clinical and neurobiological aspects. *Autonomic neuroscience : basic & clinical* 2006;129(1-2):99-106. doi: 10.1016/j.autneu.2006.07.023 [published Online First: 2006/09/12]

51. Atlantis E, Baker M. Obesity effects on depression: Systematic review of epidemiological studies. *International journal of obesity (2005)* 2008;32:881-91. doi: 10.1038/ijo.2008.54 [published Online First: 2008/04/17]

52. de Wit L, Luppino F, van Straten A, et al. Depression and obesity: A meta-analysis of community-based studies. *Psychiatry research* 2010;178:230-35. doi: 10.1016/j.psychres.2009.04.015 [published Online First: 2010/05/14]

53. Luppino FS, de Wit LM, Bouvy PF, et al. Overweight, obesity, and depression: A systematic review and meta-analysis of longitudinal studies. *Archives of general psychiatry* 2010;67:220-29. doi: 10.1001/archgenpsychiatry.2010.2 [published Online First: 2010/03/03]

54. Wang T, Xiao S, Yang C, et al. Prevalence and incidence of depression disorder and cognitive impairment in the elderly in Shanghai, China. *Alzheimer's & Dementia* 2015;11(7):P832-P33.

55. Li J, Cacchione PZ, Hodgson N, et al. Afternoon napping and cognition in Chinese older adults: Findings from the China Health and Retirement Longitudinal Study Baseline

Assessment. *Journal of American Geriatrics Society* 2017;65:373-80. doi: 10.1111/jgs.14368 [published Online First: 2016/12/21]

56. Avasthi A, Grover S. Clinical practice guidelines for management of depression in elderly. *Indian journal of psychiatry* 2018;60:S341-S62. doi: 10.4103/0019-5545.224474 [published Online First: 2018/03/15]

57. Zhang Y, Ting RZ, Yang W, et al. Depression in Chinese patients with type 2 diabetes: Associations with hyperglycemia, hypoglycemia, and poor treatment adherence. *Journal of diabetes* 2015;7:800-8008. doi: 10.1111/1753-0407.12238 [published Online First: 2014/10/29]

58. Fischer MJ, Kimmel PL, Greene T, et al. Elevated depressive affect is associated with adverse cardiovascular outcomes among African Americans with chronic kidney disease. *Kidney international* 2011;80:670-78. doi: 10.1038/ki.2011.153 [published Online First: 2011/06/03]

Tables

Table 1. Baseline characteristics of the CHARLS participants free of depressive symptoms

Variable	Distribution
N	10,288
age, years, mean (SD)	58.5 (9.8)
Male, n (%)	5845 (50.7%)
Living in rural areas, n (%)	8,440 (73.3%)
Education, n (%)	
No formal education or illiterate	2,736 (23.7%)
Some primary school	1,804 (15.7%)
Finished primary school	2,590 (22.5%)
Junior high school or above	4,394 (38.1%)
Currently married, n (%)	10,375 (90.0%)
Smoking status, n (%)	
Current smoker	3,629 (31.5%)
Former smoker	1,034 (9.0%)
Never smoking	6,868 (60.0%)
Drinking status, n (%)	
Regular drinkers	1,951 (17.9%)
Occasional drinkers	476 (4.4%)
Former drinkers	646 (5.9%)
Never drinking	7,833 (71.8%)
Weight, kg, mean (SD)	60 (11.8)
Height, m, mean (SD)	1.6 (0.1)
Body mass index, kg/m^2, mean (SD)	23.7 (4)
Sleeping duration, hours, mean (SD)	6.7 (1.7)
CES-D short form score	5.1 (3.3)
Self-perceived health status, n (%)	
Excellent	483 (4.2%)
Very good	1,744 (15.1%)
Good	4,136 (35.9%)
Fair	3,977 (34.5%)
Poor	1,187 (10.3%)
Chronic conditions, n (%)	
Hypertension	4,045 (40.3%)
Dyslipidemia	1,016 (9.0%)
Diabetes	1,210 (15.0%)
Cancer	97 (0.8%)
Liver disease	387 (3.4%)
Heart disease	1,162 (10.1%)
Stroke	188 (1.6%)
Kidney disease	563 (4.9%)

Gastrointestinal disease	2,180 (18.9%)
Dementia	105 (0.9%)
Arthritis	3,221 (28.0%)
Asthma	312 (2.7%)

Note. CES-D=Center for Epidemiologic Study of Depression short form; SD=standard deviation.

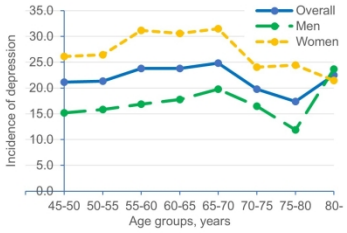
Table 2. Incidence of depressive symptoms among the CHARLS participants

	Ever having depressive symptoms	Depressive symptoms in both visits 2 & 3	Depressive symptoms in 2 years	Depressive symptoms in 4 years
Overall	22.3 (21.3-23.3)	4.4 (4.0-4.9)	13.2 (12.5-14.1)	16.8 (15.9-17.7)
Rural	25.7 (24.6-26.8)	5.3 (4.8-5.8)	15.3 (14.3-16.2)	18.8 (17.8-19.8)
Urban	15.3 (13.4-17.2)	2.6 (1.9-3.3)	9.0 (7.4-10.6)	12.2 (10.4-14.1)
Men	16.7 (15.5-17.9)	3.0 (2.5-3.5)	9.9 (9.0-10.9)	12.2 (11.1-13.2)
Women	27.9 (26.4-29.4)	5.8 (5.1-6.6)	16.6 (15.3-17.9)	21.5 (20.1-22.9)

Table 3. Raw and multi-variates adjusted associations with the incidence of depressive symptoms in 4 years of follow-up.

	Multi-Variate Adjusted		*Raw Association*	
Variables	OR (95% CI)	P	OR (95% CI)	*P*
Age, per year older	0.99 (0.98-0.99)	**0.001**	0.99 (0.99-1.00)	0.59
Male vs. Female	0.60 (0.51-0.71)	**<.0001**	0.51 (0.46-0.56)	**<.0001**
Education level				
No formal education or illiterate	ref.	**<.0001**	ref.	**<.0001**
Some primary school	1.06 (0.90-1.25)		0.93 (0.80-1.08)	
Finished primary school	0.83 (0.71-0.97)		0.67 (0.57-0.77)	
Junior high school or above	0.71 (0.61-0.84)		0.48 (0.42-0.55)	
Rural vs. Urban	1.61 (1.38-1.88)	**<.0001**	1.72 (1.50-1.96)	**<.0001**
Not married vs Married	1.25 (1.04-1.51)	**0.02**	1.28 (1.08-1.51)	**0.004**
Smoking status				
Non-smokers	ref.		ref.	
Current smokers	1.02 (0.86-1.20)	**0.03**	0.51 (0.41-0.62)	**<.0001**
Former smokers	0.75 (0.59-0.96)		0.68 (0.60-0.76)	
Drinking status				
Never drinkers	Ref.		ref.	
Former drinkers	1.02 (0.80-1.30)	0.15	0.84 (0.67-1.04)	**<.0001**
Occasional drinkers	0.79 (0.59-1.06)		0.59 (0.45-0.78)	
Regular drinkers	0.85 (0.71-1.01)		0.59 (0.51-0.68)	
Body mass index, per 1 kg/m^2 increase	0.99 (0.98-1.01)	0.20	0.99 (0.98-1.00)	0.14
Self-perceived health status				
Excellent	0.36 (0.25-0.52)	**<.0001**	0.28 (0.20-0.39)	**<.0001**
Very good	0.36 (0.29-0.45)		0.28 (0.23-0.35)	
Good	0.53 (0.44-0.63)		0.45 (0.38-0.53)	
Fair	0.61 (0.52-0.73)		0.56 (0.48-0.66)	
Poor	ref.		ref.	
Sleep duration, per hour longer	0.89 (0.87-0.92)	**<.0001**	0.88 (0.85-0.90)	**<.0001**
Hypertension (Y vs. N)	1.07 (0.95-1.21)	0.25	1.07 (0.96-1.18)	0.22
Dyslipidemia (Y vs. N)	0.85 (0.69-1.04)	0.12	0.91 (0.76-1.09)	0.29
Diabetes (Y vs. N)	1.19 (1.00-1.42)	**0.04**	1.11 (0.95-2.30)	0.19
Cancer (Y vs. N)	0.92 (0.48-1.77)	0.80	1.17 (0.65-2.12)	0.61
Chronic Lung Disease (Y vs. N)	1.18 (0.97-1.44)	0.10	1.33 (1.12-1.58)	**0.001**
Chronic Liver Disease (Y vs. N)	0.90 (0.67-1.22)	0.51	1.04 (0.79-1.37)	0.81
Heart Disease (Y vs. N)	1.06 (0.88-1.28)	0.54	1.27 (1.08-1.49)	**0.004**
Stroke (Y vs. N)	0.88 (0.56-1.39)	0.59	1.12 (0.75-1.66)	0.58
Chronic Kidney Disease (Y vs. N)	1.32 (1.04-1.67)	**0.02**	1.45 (1.16-1.80)	**0.001**
Chronic Digestive Disorders (Y vs. N)	1.15 (1.01-1.31)	**0.04**	1.43 (1.26-1.61)	**<.0001**
Psychological Disorders (Y vs. N)	1.00 (0.53-1.89)	0.99	1.44 (0.81-2.56)	0.22
Dementia (Y vs. N)	1.31 (0.72-2.38)	0.37	1.15 (0.67-1.97)	0.62
Arthritis (Y vs. N)	1.43 (1.28-1.61)	**<.0001**	1.72 (1.54-1.91)	**<.0001**
Asthma (Y vs. N)	1.25 (0.90-1.75)	0.19	1.43 (1.06-1.91)	**0.02**

Note. CI=confidence interval; OR=odds ratio. All analysis was conducted at a 5% significance level.



254x190mm (300 x 300 DPI)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort 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	3
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	6-7
Objectives	3	State specific objectives, including any prespecified hypotheses	7
Methods			
Study design	4	Present key elements of study design early in the paper	8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	8-9
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	8
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	9-11
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	9
Bias	9	Describe any efforts to address potential sources of bias	17
Study size	10	Explain how the study size was arrived at	8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	12
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	12
		(*b*) Describe any methods used to examine subgroups and interactions	NA
		(*c*) Explain how missing data were addressed	NA
		(*d*) If applicable, explain how loss to follow-up was addressed	NA
		(*e*) Describe any sensitivity analyses	NA
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	8
		(b) Give reasons for non-participation at each stage	NA
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	13
		(b) Indicate number of participants with missing data for each variable of interest	NA
		(c) Summarise follow-up time (eg, average and total amount)	8
Outcome data	15*	Report numbers of outcome events or summary measures over time	NA
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	11, 13-14
		(*b*) Report category boundaries when continuous variables were categorized	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	14
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	17
Generalisability	21	Discuss the generalisability (external validity) of the study results	17
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	20

*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.