Postprint: A Correlation Study Between the Temperature-Humidity Index of the Twenty-Four Solar Terms and Depression

Authors: Zhang Wenjing, Ge Xufeng, Ou Xiwen, Cai Yuyang, Yang Ling, Liu Fang, Yang Ling, Liu Fang

Date: 2023-06-08T00:00:00+00:00

Abstract

The global population of depression patients has exceeded 300 million, and its high disability rate has attracted widespread international attention. Currently, research on the relationship between the temperature-humidity index (Humidex) and depression remains limited.

To explore the relationship between Humidex across the 24 solar terms and depression.

Data on depression patients visiting the psychiatric department of Shanghai Jiading District Mental Health Center from 2016-10-08 to 2019-10-07 were collected, including gender, age, visit time, and numbers of general and specialist outpatient visits. Daily mean temperature, relative humidity, rainfall, air pressure, and mean wind speed data for Jiading District from 2016-10-08 to 2019-10-07 were collected from publicly available data from the Shanghai Meteorological Bureau to calculate Humidex. Patients were divided into different age groups: $ $18 years (n=157), 19-44 years (n=3,099), 45-59 years (n=4,848), 60-74 years (n=6,270), and $ $75 years (n=3,915). The relationship between Humidex across the 24 solar terms and depression was estimated using a combination of quasi-Poisson distribution and distributed lag non-linear models. Pearson correlation analysis was used to calculate the correlation between Humidex and meteorological variables. Using median Humidex as the reference, the relative risk (RR) of depression associated with Humidex across the 24 solar terms was calculated.

A total of 18,289 depression patient visits were included from 2016-10-08 to 2019-10-07, comprising 6,900 male patients and 11,389 female patients. From 2016-10-08 to 2017-10-07, the Minor Cold solar term had the lowest mean Humidex and the highest number of depression patients; the Major Heat solar term

had the highest mean Humidex and the lowest number of depression patients. From 2017-10-08 to 2018-10-07, the Major Cold solar term had the lowest mean Humidex and the highest number of depression patients; the Major Heat solar term had the highest mean Humidex and the lowest number of depression patients. From 2018-10-08 to 2019-10-07, the Major Cold solar term had the lowest mean Humidex and the highest number of depression patients; the Major Heat solar term had the highest mean Humidex and the lowest number of depression patients. Humidex across the 24 solar terms showed a non-linear relationship with depression risk in the total population. From 2016-10-08 to 2019-10-07, for the total population, males, females, and the age groups $ $18 years, 19-44 years, 45-59 years, 60-74 years, and $ $75 years, the solar terms corresponding to the top two Humidex values for depression risk distribution were Major Cold and Beginning of Spring, while the solar term corresponding to the lowest Humidex value for depression risk distribution was Major Heat. In the total depression population, the maximum lag effect occurred on day 10 after the Major Cold and Beginning of Spring solar terms [RR=1.020, 95%CI (1.001, 1.040)], while a lag effect appeared on day 8 after the Major Heat solar term and persisted until day 9. The 60-74 years age group showed a lag effect on day 7 after the Major Cold and Beginning of Spring solar terms, with the maximum lag effect on day 9 [RR=1.054, 95%CI (1.007, 1.104)], persisting until day 11. The male depression population showed lag effects on day 1 and day 8 after the Major Heat solar term, persisting until day 2 and day 10 respectively, with the maximum lag effect occurring on day 10 [RR=0.952, 95%CI (0.911, 0.994)]; the 60-74 years age group showed a lag effect on day 8 after the Major Heat solar term, persisting until day 9.

Humidex during the Major Cold and Beginning of Spring solar terms is a risk factor for depression, while high Humidex during the Major Heat solar term is a protective factor against depression. Clinically, precise diagnosis and treatment should be implemented for different depression patient populations based on the varying Humidex across different solar terms, and individualized intervention plans should be formulated.

Full Text

Relationship between the Temperature-Humidity Index of Twenty-four Solar Terms and Depression

WENJING Zhang[1], XUFENG Ge[2], XIWEN Ou[1], YUYANG Cai[3], LING Yang[4], *FANG Liu*[1]

[1]Department of Geriatrics, Xinhua Hospital, Shanghai Jiao Tong University School of Medicine, Shanghai 200092, China
[2]Psychology Department, Mental Health Center of Jiading District, Shanghai 201822, China
[3]School of Public Health, Shanghai Jiao Tong University School of Medicine, Shanghai 200025, China

[4]Department of Geriatrics, Shanghai Fourth People' s Hospital Affiliated to Tongji University, Shanghai 200434, China

Corresponding authors: LING Yang, Chief Physician; E-mail: 2205603@tongji.edu.cn; FANG Liu, Chief Physician; E-mail: liufang@xinhuamed.com.cn

Abstract

Background: The global number of patients with depression has exceeded 300 million, and its high disability burden has attracted worldwide attention. However, the relationship between temperature-humidity index (Humidex) and depression remains to be explored. **Objective:** To explore the relationship between Humidex of the twenty-four solar terms and depression. **Methods:** Outpatient data for patients with depression admitted to the psychology department of Mental Health Center of Jiading District from October 8, 2016 to October 7, 2019 were collected, including gender, age, treatment time, and numbers of outpatient and specialist visits. Daily mean temperature, relative humidity, rainfall, air pressure and mean wind speed data for Jiading District from October 8, 2016 to October 7, 2019 were collected from the Shanghai Meteorological Bureau to calculate Humidex. Patients were stratified by age group: $ $18 years (n=157), 19-44 years (n=3,099), 45-59 years (n=4,848), 60-74 years (n=6,270) and $ $75 years (n=3,915). The relationship between Humidex across the twenty-four solar terms and depression was estimated using a combination of quasi-Poisson distribution and distributed-lag nonlinear model. Correlation between Humidex and meteorological variables was calculated using Pearson correlation analysis. Using median Humidex as reference, relative risks (RR) of Humidex and depression were calculated for the twenty-four solar terms. **Results:** A total of 18,289 patients with depression were included from October 8, 2016 to October 7, 2019, including 6,900 males and 11,389 females. Humidex showed a nonlinear relationship with depression risk in the overall population. The top two solar terms corresponding to highest depression risk distribution for total population, males, females, and all age groups were Great Cold and Beginning of Spring, while Great Heat corresponded to the lowest risk. The maximum lag effect in the total population occurred on day 10 after Great Cold and Beginning of Spring [RR=1.020, 95%CI (1.001, 1.040)], and on day 8 after Great Heat, lasting until day 9. In the 60-74 years group, the lag effect appeared on day 7 after Great Cold and Beginning of Spring, with maximum effect on day 9 [RR=1.054, 95%CI (1.007, 1.104)], lasting until day 11. In male patients, lag effects occurred on days 1 and 8 after Great Heat, lasting until days 2 and 10 respectively, with maximum effect on day 10 [RR=0.952, 95%CI (0.911, 0.994)]. **Conclusion:** Low Humidex during Great Cold and Beginning of Spring are risk factors for depression, while high Humidex during Great Heat is a protective factor. Clinically, accurate diagnosis and treatment should be provided for different depression patient populations according to Humidex variations across solar terms, and individualized intervention programs should be

formulated.

Keywords: Depressive disorder; Humidity; Temperature; Humidex; Solar terms and medicine; 24 solar terms; Correlation study

Introduction

Depression prevalence has increased significantly in recent years. Reports estimate that approximately 322 million people worldwide suffer from depression, accounting for 4.4% of the global population, with disability-adjusted life years far exceeding those of cardiovascular diseases, attracting widespread attention. The 2021 China Mental Health Survey showed that the prevalence of depression in China is 3.4%, with 95 million patients, and about 280,000 suicides occur annually, of which 40% involve individuals with depression. Multiple studies have demonstrated that neuropsychiatric diseases are associated with meteorological elements such as temperature, humidity, air pressure, and sunshine duration. China' s twenty-four solar terms— "Spring rain awakens spring, clear valley sky; Summer fullness connects summer heat; Autumn dew brings cold frost; Winter snow connects winter cold" —represent the wisdom of our ancestors in summarizing annual natural rhythm changes. These terms play important roles in guiding agricultural production and constitute an important part of China' s excellent traditional culture, having been included in the Representative List of the Intangible Cultural Heritage of Humanity. Currently, research on the relationship between Humidex of the twenty-four solar terms and depression is relatively scarce. Previous studies have focused on single indicators such as mean temperature, humidity, and sunshine duration, ignoring the interactive effects of multiple factors on depression patients. This study analyzes data from depression patients at Shanghai Jiading District Mental Health Center and meteorological data from Jiading District to comprehensively investigate the relationship between Humidex of the twenty-four solar terms and depression, revealing trends in depression patient numbers across solar terms to provide theoretical basis for reducing depression prevalence and implementing preventive measures.

Methods

1.1 Data Collection Outpatient data for patients with depression from the psychology department of Shanghai Jiading District Mental Health Center were collected from October 8, 2016 to October 7, 2019, including gender, age, treatment time, and numbers of outpatient and specialist visits. Inclusion criteria: Patients met the diagnostic criteria for depression (ICD-10 code F32) in the International Classification of Diseases (10th Revision). Exclusion criteria: (1) patients previously diagnosed with other psychiatric disorders besides depression; (2) depression caused by organic lesions; (3) history of severe head trauma.

This study was approved by the Medical Ethics Committee of Xinhua Hospital Affiliated to Shanghai Jiao Tong University School of Medicine.

Daily mean temperature, relative humidity, rainfall, air pressure and mean wind speed data for Jiading District from October 8, 2016 to October 7, 2019 were collected from data published by the Shanghai Meteorological Bureau. Humidex was calculated using the formula: Humidex=tem+ 7.5 tem 237.7+tem -10] , where tem is daily mean temperature and hum is relative humidity. Sample size estimation for the descriptive study used the formula $N = Z^2 \times P \times (1\text{-}P)/\ ^2$, where N is sample size, Z is the statistic (Z=1.96 for 95% confidence interval), is the error value, and P is the probability value. A Chinese cross-sectional epidemiological study on mental disorders showed a lifetime prevalence of depression of 3.4%, yielding N=11,364.7, rounded to N=11,365. The study actually included 18,289 cases. The twenty-four solar terms were plotted from Cold Dew to Autumnal Equinox to illustrate the relationship between solar terms, Humidex, and depression patient numbers.

1.2 Grouping Based on references, patients were stratified by age group: $ $18 years (n=157), 19-44 years (n=3,099), 45-59 years (n=4,848), 60-74 years (n=6,270) and $ $75 years (n=3,915).

1.3 Statistical Analysis Data analysis was performed using SPSS 16.0 and R 4.2.0 software. Normally distributed measurement data were expressed as ($\bar{x}\pm s$). Since daily depression incidence is a low-probability event following a Poisson distribution, the relationship between Humidex of the twenty-four solar terms and depression was estimated using a combination of quasi-Poisson distribution and distributed-lag nonlinear model. Pearson correlation analysis was used to calculate correlations between Humidex and meteorological variables. When the correlation coefficient (r) between Humidex and a single meteorological variable was >0.7, it was considered strong correlation and the variable was excluded from the model.

The model was: Log[E(Y)]=α+βX , +ns(Wind speed , df=3)+ns(Time, df=5/year)+DOW +Holiday +Experts , where E(Y) represents the expected count of depression patients on day t, α is the intercept, X represents Humidex, l is the maximum lag days, β is the coefficient of Humidex, Wind speed is wind speed on day t, Time reflects the time variable, and ns is the natural cubic spline function. ns(Time, df) controlled for seasonal and long-term trends using natural spline functions, including categorical variables such as day of week (DOW), holidays (Holiday), and specialist clinics (Experts). Based on relevant literature, natural cubic splines with 3 df were used for wind speed, and natural cubic splines with 5 df per year were used to control long-term trends and seasonal distribution. Each solar term averages 15 days, and the maximum lag days was set at 15 based on Akaike Information Criterion (AIC). Using median Humidex as reference, relative risk rates (RR) of Humidex and depression were calculated for the twenty-four solar terms. Effect modification by gender and

age grouping was examined by calculating 95%CI for differences in effect values across populations. P<0.05 was considered statistically significant.

Results

2.1 Statistical Description From October 8, 2016 to October 7, 2019, a total of 18,289 patients with depression were included, including 6,900 males and 11,389 females. The distribution of meteorological factors in Jiading District during the study period is shown in Table 1 .

From October 8, 2016 to October 7, 2017, the Lesser Cold solar term had the lowest average Humidex and highest number of depression patients, while the Great Heat solar term had the highest average Humidex and lowest number of patients. From October 8, 2017 to October 7, 2018, the Great Cold solar term had the lowest average Humidex and highest number of depression patients, while the Great Heat solar term had the highest average Humidex and lowest number of patients. From October 8, 2018 to October 7, 2019, the Great Cold solar term had the lowest average Humidex and highest number of depression patients, while the Great Heat solar term had the highest average Humidex and lowest number of patients. The distribution of average Humidex and depression patient numbers across the twenty-four solar terms from 2016–2019 is shown in Figure 1 [Figure 1: see original paper].

2.2 Variable Inclusion in Distributed-Lag Nonlinear Model Correlation analysis showed that Humidex was strongly correlated with daily mean temperature (r=0.899) and air pressure (r=-0.832) (P<0.05), so these variables were excluded from the model. Humidex showed weak correlation with relative humidity (r=0.028), wind speed (r=-0.023), and rainfall (r=0.044) (P>0.05). Since Humidex is calculated from daily mean temperature and relative humidity, relative humidity was excluded from the model. Due to high dispersion of rainfall data, it was also excluded. The final model included Humidex and wind speed.

2.3 Effects of Humidex on Depression Across Solar Terms Using median Humidex (0) as reference, Humidex showed a nonlinear relationship with depression risk in the overall population. As Humidex increased, depression risk in the total population showed a trend of first decreasing, then increasing, then decreasing again. From October 8, 2016 to October 7, 2019, the top two solar terms corresponding to highest depression risk distribution were Great Cold and Beginning of Spring, while Great Heat corresponded to the lowest risk. Dose-response plots for Humidex and depression in different gender and age groups showed similar trends: as Humidex increased, depression risk distribution generally showed a pattern of first decreasing, then increasing, then decreasing. For males, females, and all age groups ($ $18, 19–44, 45–59, 60–74, and $ $75 years),

the top two solar terms with highest risk distribution were Great Cold and Beginning of Spring, while Great Heat had the lowest risk distribution (Figure 2 [Figure 2: see original paper]).

2.4 Lag Effects of Humidex on Depression The maximum lag effect in the total depression population occurred on day 10 after Great Cold and Beginning of Spring [RR=1.020, 95%CI (1.001, 1.040)], with lag effects appearing on day 8 after Great Heat and lasting until day 9. Subgroup analysis revealed that only the 60–74 years group showed lag effects after Great Cold and Beginning of Spring, appearing on day 7, peaking on day 9 [RR=1.054, 95%CI (1.007, 1.104)], and lasting until day 11. Only males and the 60–74 years group showed lag effects after Great Heat. In male patients, lag effects appeared on days 1 and 8 after Great Heat, lasting until days 2 and 10 respectively, with maximum effect on day 10 [RR=0.952, 95%CI (0.911, 0.994)]. In the 60–74 years group, lag effects appeared on day 8 after Great Heat and lasted until day 9 (Figure 3 [Figure 3: see original paper]).

Discussion

This study analyzed the correlation between Humidex of the twenty-four solar terms and depression from October 8, 2016 to October 7, 2019 using a distributed-lag nonlinear model. The results showed a nonlinear relationship between Humidex and depression, with Great Cold and Beginning of Spring having the highest risk distribution and Great Heat having the lowest. These findings align with previous research showing depression worsens in winter and improves in summer.

Traditional Chinese medicine holds that liver yang represents the spring-born lesser yang qi, which is initially weak and vulnerable to damage. When cold pathogens are strong, liver yang is damaged, and the liver loses its ascending and smoothing properties, leading to stagnation. In winter, depressed patients have reduced liver dredging function, making them more susceptible to depression.

Research suggests that high incidence of depression in winter may be related to changes in daylight hours and melatonin levels. Clinical trials have found significant efficacy of light therapy for seasonal depression. Neuroimaging studies indicate that light therapy has antidepressant effects through a retinal disynaptic circuit affecting depressive-like behavior, with neural circuits influenced by light dose and wavelength. Melatonin, derived from the pineal gland, regulates circadian rhythms and has antidepressant functions, possibly through monoamine neurotransmitters and the hypothalamic-pituitary-adrenal axis.

Stratified analysis by gender and age groups revealed similar risk distribution trends across the twenty-four solar terms for both male and female patients, with Great Cold and Beginning of Spring showing highest risk and Great Heat

showing lowest risk. Different age groups showed similar patterns, though maximum lag risks and timing differed. This study found more female patients than male, consistent with research on depression rehospitalization and depression status among middle-aged and elderly Chinese. This may be partly due to female hormones and women' s greater tendency to express depressive emotions. Depression patients were concentrated in the 60–74 years age group. Depression in elderly people is influenced by multiple factors including economic pressure, family atmosphere, spousal death, declining physical function, and poor ability to cope with cold weather changes. Depression is also associated with various diseases, with research linking depression and hypertension in elderly populations. Depression often coexists with chronic diseases, increasing family burden, severely reducing quality of life, and potentially causing death, posing significant challenges to families and society.

This study has several limitations: (1) It focused on outpatient data from Shanghai Jiading District Mental Health Center. Shanghai has a subtropical monsoon climate, which may differ from other regions in China, limiting generalizability. Future research should collect depression data nationwide. (2) This study examined short-term rather than long-term effects of Humidex across solar terms; longer time periods should be explored. (3) The study may have included patients who regularly visited the clinic for reasons unrelated to solar term Humidex, but data limitations prevented exclusion. (4) The study did not collect comprehensive individual characteristics such as education level, family economic status, family atmosphere, employment status, or chronic disease status. Future research should incorporate these factors for more comprehensive analysis and collect longer-term samples for validation.

Conclusion

Low Humidex during Great Cold and Beginning of Spring are risk factors for depression, while high Humidex during Great Heat is a protective factor. Clinically, accurate diagnosis and treatment should be provided for different depression patient populations according to Humidex variations across solar terms, and individualized intervention programs should be formulated.

Author Contributions

WENJING Zhang and XUFENG Ge contributed to manuscript writing, data collection, and investigation. XIWEN Ou and YUYANG Cai performed statistical analysis. LING Yang and FANG Liu supervised the study and take responsibility for the article.

Conflict of Interest

The authors declare no conflict of interest.

References

[1] PROF YUEQIN HUANG, et al. Prevalence of mental disorders in China: a cross-sectional epidemiological study. Lancet Psychiatry, 2019, 6(3): 211-224. DOI:10.1016/S2215-0366(18)30511-X.

[2] TRAN B X, HA G H, NGUYEN D N, et al. Global mapping of interventions to improve quality of life of patients with depression during 1990-2018. Qual Life Res, 2020, 29(9): 2333-2343. DOI:10.1007/s11136-020-02512-7.

[3] BRANDL E J, LETT T A, BAKANIDZE G, et al. Weather conditions influence the number of psychiatric emergency room patients. Int J Biometeorol, 2018, 62(5): 843-850. DOI:10.1007/s00484-017-1485-z.

[4] AGUGLIA A, SERAFINI G, ESCELSIOR A, et al. What is the role of meteorological variables on involuntary admission in psychiatric ward? An Italian cross-sectional study. Environ Res, 2020, 180: 108800. DOI:10.1016/j.envres.2019.108800.

[5] CHAN E Y Y, LAM H C Y, SO S H W, et al. Association between ambient temperatures and mental disorder hospitalizations in a subtropical city: a time-series study of Hong Kong special administrative region. Int J Environ Res Public Health, 2018, 15(4): 754. DOI:10.3390/ijerph15040754.

[6] NAI-TZU CHEN. Long-term exposure to high temperature and its ubiquitous anticancer effects. Mol Cell Biochem, 2019, 462(1/2): 133-155. DOI:10.1007/s11010-019-03511-X.

[7] JIANG Q S, HAN Y J, LUO J, et al. Twenty-four solar terms and traditional Chinese medicine. China J Tradit Chin Med Pharm, 2019, 34(4): 1653-1656.

[8] YANG W Y. Epidemic characteristics and changing trends of diabetes in China. Sci Sin Vitae, 2018, 48(8): 812-819. DOI:10.1360/N052018-00150.

[9] LENG H, YAN T J, YUAN Q. Research progress and implications of blue-green space' s mental health effects. Urban Plann Int, 2022, 37(2): 34-43, 52. DOI:10.19830/j.upi.2020.708.

[10] FAN C N, LIU F F, ZHAO X, et al. An alternative comprehensive weather index to quantify the interactive effect of temperature and relative humidity on hand, foot and mouth disease: a two-stage time series study including 143 cities in mainland China. Sci Total Environ, 2020, 740: 140106. DOI:10.1016/j.scitotenv.2020.140106.

[11] WU Y D, YAO Z H, MA G Y, et al. Effects of extreme precipitation on hospitalization risk and disease burden of schizophrenia in urban and rural Lu'

an, China, from 2010 to 2019. Environ Sci Pollut Res, 2022, 29(13): 19176-19184. DOI:10.1007/s11356-021-16913-9.

[12] WANG J N, YU L X, DENG J X, et al. Short-term effect of meteorological factors on the risk of rheumatoid arthritis hospital admissions: a distributed lag non-linear analysis in Hefei, China. Environ Res, 2022, 207: 112168. DOI:10.1016/j.envres.2021.112168.

[13] SUI B, ZHANG J J. Connotation, value and inheritance development of twenty-four solar terms. Chin Agric Hist, 2020, 39(6): 111-117. DOI:10.3969/j.issn.1672-2787.2021.03.010.

[14] ZHAO R R, YIN S Y, WANG S X. Temperature change characteristics of twenty-four solar terms in North China Plain from 1961 to 2014. Acta Scientiarum Naturalium Universitatis Sunyatseni, 2017, 56(6): 38-47. DOI:10.13471/j.cnki.acta.snus.2017.06.005.

[15] WANG X H, HAN Z Y, CHEN J X, et al. Discussion on light therapy for depression based on Chongyang theory. China J Tradit Chin Med Pharm, 2022, 37(4): 2010-2013. DOI:10.19621/j.cnki.11-3555/r.2021.1507.

[16] JIANG D Y, WANG C T, HAN J R, et al. Discussion on image thinking of emotional disharmony in cold regions. China J Tradit Chin Med Pharm, 2021, 36(6): 3523-3525. DOI:10.13194/j.issn.1673-842x.2014.12.004.

[17] WIRZ-JUSTICE A. Seasonality in affective disorders. Gen Comp Endocrinol, 2018, 258: 244-249. DOI:10.1016/j.ygcen.2017.07.010.

[18] LI P P, TAN B, HUANG X N, et al. Research progress on seasonal affective disorder. China J Tradit Chin Med Pharm, 2019, 34(7): 3135-3137. DOI:10.3969/j.issn.1006-2157.2013.03.003.

[19] ZHAI Q, FENG L, ZHANG G F, et al. Research progress on seasonal affective disorder and light therapy. Chin Gen Pract, 2020, 23(26): 3363-3368. DOI:10.12114/j.issn.1007-9572.2019.00.680.

[20] HUANG L, XI Y, PENG Y F, et al. A visual circuit related to habenula underlies the antidepressive effects of light therapy. Neuron, 2019, 102(1): 128-142.e8. DOI:10.1016/j.neuron.2019.01.037.

[21] PJREK E, FRIEDRICH M E, CAMBIOLI L, et al. The efficacy of light therapy in the treatment of seasonal affective disorder: a meta-analysis of randomized controlled trials. Psychother Psychosom, 2020, 89(1): 17-24. DOI:10.1159/000502891.

[22] LI Y, RU T T, LI S Y, et al. Effects of ambient light on mood and its mechanism. Adv Psychol Sci, 2022, 30(2): 389. DOI:10.3724/sp.j.1042.2022.00389.

[23] BHATTACHARYA S, PATEL K K, DEHARI D, et al. Melatonin and its ubiquitous anticancer effects. Mol Cell Biochem, 2019, 462(1/2): 133-155. DOI:10.1007/s11010-019-03511-X.

[24] YAN J Q, PENG X D, LIU T B. Correlation analysis between recurrent depressive disorder onset and seasonal meteorological factors. Sichuan Ment Health, 2019, 32(4): 319-323. DOI:10.11886/j.issn.1007-3256.2019.04.006.

[25] LIAO S Y, WANG Y Y, CAI Y, et al. Analysis of readmission and influencing factors in patients with depression. Chin J Public Health, 2022, 38(12): 1510-1516. DOI:10.11847/zgggws1137561.

[26] WU N W, YANG F, XIA J, et al. Analysis of depression status and influencing factors among middle-aged and elderly people in China. J Sichuan Univ (Med Sci), 2021, 52(5): 767-771. DOI:10.12182/20210960507.

[27] FARAVELLI C, ALESSANDRA SCARPATO M, CASTELLINI G, et al. Gender differences in depression and anxiety: the role of age. Psychiatry Res, 2013, 210(3): 1301-1303. DOI:10.1016/j.psychres.2013.09.027.

[28] LI C, JIANG S, ZHANG X. Intergenerational relationship, family social support, and depression among Chinese elderly: A structural equation modeling analysis. J Affect Disord, 2019, 248: 73-80. DOI:10.1016/j.jad.2019.01.032.

[29] ZHU C S, LIAN Z W, CUI Y M. Association between depression and chronic diseases among middle-aged and elderly Chinese. J Peking Univ (Health Sci), 2023: 1-14. (2023-04-22)[2023-04-23]. http://kns.cnki.net/kcms/detail/11.4691.R.20220422.1128.008.html.

[30] GUO R Q, HU Y, MIN S H, et al. Analysis of disease burden and changing trends of depression among Chinese residents from 1990 to 2019. Mod Prev Med, 2022, 49(6): 981-985, 1031. DOI:10.12114/j.issn.1007-9572.2021.01.207.

Received: January 28, 2023; Revised: May 22, 2023
Edited by: LIN Zou

Note: Figure translations are in progress. See original paper for figures.