Research article

What exacerbates and what eases Chinese rural residents' depression during the COVID-19?

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ABSTRACT

During the COVID-19 pandemic, there has been a growing prevalence of mental disorders, particularly in China, where anti-epidemic measures have been more stringent compared to other countries. This has resulted in a heightened psychological burden on individuals. However, the actual psychological impacts of COVID-19 on Chinese residents have not been clearly established. In this study, we aimed to investigate the effects of various factors, including personal and household characteristics, social networks, and epidemic-related variables (such as rural residents' knowledge of COVID-19 virus transmission and prevention), on rural residents' depression. Using a two-year balanced panel dataset encompassing 152 villages and 676 samples in both 2019 and 2020, we employed the Ordinary Least Squares (OLS) model to estimate the influence of these factors and compare their coefficients to examine the changes in rural residents' depression between the pre-epidemic and during-epidemic periods. Our study highlights significant factors contributing to rural residents' depression during the COVID-19 pandemic, including isolation (2.063, $p < 0.01$) and concern about COVID-19 infection (0.128, $p < 0.05$). Conversely, factors such as health status (-0.714, $p < 0.01$) and the number of friends (-0.017, $p < 0.01$) were found to significantly alleviate depression among rural residents. Moreover, we identify key moderators that mitigate the negative impact of infection concerns on mental health. Specifically, the health status of rural residents (-0.166, $p < 0.01$), the size of their family network (-0.036, $p < 0.05$), and their knowledge of COVID-19 transmission and prevention (-0.184, $p < 0.05$) significantly moderated the relationship between infection concerns and depression. These findings contribute to a better understanding of the psychological implications of the pandemic and provide valuable insights for the development of targeted interventions to address mental health challenges in rural populations.

1. Introduction

Mental health plays a pivotal role in the well-being and progress of individuals, families, and society as a whole [1]. For individuals, "No health without mental health" has been advocated by numerous organizations, including the World Health Organization, the Pan American Health Organization, the EU Council of Ministers, the World Federation of Mental Health, and the UK Royal College of Psychiatrists. In particular, mental disorders may cause long-term disability, dependency, and mortality [2]. In a familial context,

personal emotions hold the power to influence the collective emotional state of the entire family unit. When an individual within the family grapples with mental health issues, it frequently gives rise to adverse emotions that permeate the entire household [3]. Moreover, the mental well-being of the entire family has a significant impact on their economic standing. Research indicates that with each 1 % improvement in the overall mental health of a family, there is an associated increase in family income by approximately 1.7 %–1.9 % [4]. Research has further revealed that mental health holds greater significance as a determinant of average human capital accumulation compared to physical health conditions. To elucidate this point, an examination of American mental health spanning the period from 2008 to 2014 unveiled a noteworthy finding: for each day marked by poor mental health (PMHD), the per capita real income growth rate experienced a decline of 1.84 percentage points, resulting in an annual income reduction of $53 billion [5].

Unfortunately, individuals across the globe have been grappling with the burden of mental disorder. Disturbingly, research reveals that one-third of people in the world will suffer from a mental disorder during their lifetime, and one-third of patients seeking medical treatment in general hospitals are being treated for mental health issues [6]. Moreover, the mental well-being of rural residents demonstrates an even more precarious state when juxtaposed with that of their urban counterparts. Substantial evidence substantiates the claim that the suicide rate among rural residents surpasses that observed among urban residents [7]. Additionally, it is worth noting that mental disorders exhibit a significant prevalence among Chinese nationals, with a concerning upward trend [8,9]. Moreover, empirical evidence reveals that Chinese rural residents have consistently demonstrated comparatively lower levels of mental well-being in the past four years when compared to their urban counterparts [10], and notably, rural residents face an elevated risk of experiencing depression in contrast to urban residents [11]."

Numerous factors exert influence on individuals' overall susceptibility to depression, encompassing gender, age, education, health status, income, and social network, among others. To be more specific, extensive research supports the notion that women exhibit a higher likelihood of experiencing depression compared to men [12,13]. Notably, social disparities emerge as the foremost determinants of the gender disparity in depression, while biological factors do not appear to play a significant role in this regard [14]. Several studies have identified marital status and childcare responsibilities as intimate factors contributing to women's vulnerability to depression [14]. For instance, numerous investigations have highlighted that young married women who care for small children face heightened risks of depression [15–18]. Moreover, some studies have demonstrated that, particularly in cases of moderate depressive disorders, the influence of the marital role offers a more comprehensive explanation [19]. Furthermore, the prevalence of depression tends to increase with age [13]. This escalation in depression rates among older adults has been attributed to factors associated with aging, such as a higher proportion of women, increased physical disability, greater cognitive impairment, and lower socioeconomic status [20]. A multitude of studies have documented a negative association between higher education levels and depression among adults [21–23]. Education exerts its influence on depression through diverse underlying mechanisms, including cognitive ability, economic resources, social status, social network, and health behavior. Among these, the development of cognitive ability emerges as the most prominent pathway [24]. Additionally, individuals with poor physical health face significantly elevated risks of depression [25]. Although multiple studies have established a positive relationship between income and mental health [26], Zimmerman and Katon found that when controlling for variables such as employment status and financial strain, the association between income and depression diminishes substantially [27]. Furthermore, several investigations have highlighted the role of support from friends and relatives in alleviating depressive feelings [28]. Social network support encompasses the provision of warmth, encouragement, and assistance by friends, neighbors, and extended family members [29].

The outbreak of COVID-19 has posed a significant threat to individuals' mental well-being. Initial evidence suggests that symptoms of depression are prevalent psychological reactions to the COVID-19 pandemic [30]. Moreover, several studies have identified numerous factors arising from the pandemic that contribute to individuals' depression. These factors encompass the unpredictability and uncertainty associated with COVID-19, the implementation of lockdowns and physical distancing measures, as well as concerns regarding infection. Individuals who experienced fear of contracting or spreading the virus, exhibited obsessive cleaning behavior, expressed anxiety about the future, sadness, and uneasiness were found to display mild-level depression symptoms [31]. Furthermore, the concern about infection can be easily influenced by news and reports. Detailed studies have revealed the detrimental effects of misinformation, fabricated reports, inadequate information, and sensationalized news related to COVID-19, which intensify the general population's fear of contracting the virus [32–35]. In addition, social networks have become an expansive and intricate system for virtual interaction, connecting more than two-fifths of the global population during COVID-19. These platforms have emerged as primary channels for disseminating information during the COVID-19 crisis. However, they also pose vulnerabilities as they facilitated the rapid spread of negative information, falsehoods, and rumors, generating widespread panic among the online public. The lack of effective mechanisms to manage such impacts exacerbated the situation [36,37].

Although there have been some studies examining the psychological impact of the COVID-19 pandemic, there is a relative scarcity of research focused on China. It is important to consider that the specific impacts on Chinese residents may differ from those experienced in other countries due to various dissimilarities in how the COVID-19 pandemic unfolded domestically. Notably, the proportion of infected individuals in China relative to the overall population has remained lower than in other countries, suggesting that Chinese residents may have experienced a comparatively lower psychological burden as a result of COVID-19. However, it should be acknowledged that China implemented stricter anti-epidemic measures compared to many other countries, which could have similarly imposed a negative psychological burden on its residents. Consequently, the actual psychological impacts of COVID-19 on Chinese residents remain unclear. Furthermore, previous studies have mostly focused on a temporary timescale without accounting for respondents' pre-existing mental states. However, individuals' psychological well-being evolves over time and is influenced by changes in their environment. Therefore, it is crucial to consider respondents' mental state prior to the initial COVID-19 outbreak. Additionally, there is a paucity of research on individuals residing in rural areas of China, who may, in fact, be more vulnerable to COVID-19 compared to their urban counterparts, although there was little spread of COVID-19 in rural communities: an infection rate of

0.001 % and zero deaths reported in a study [38]. For example, rural residents confronted worse health care and government aid. Only 20 % of villagers received any form of local government aid, and only 11 % of villages received financial subsidies [38]. Given these differences and the existing gaps in previous research endeavors, this paper aims to investigate the psychological impacts of COVID-19 on Chinese rural residents while controlling for their pre-pandemic mental state. Moreover, in contrast to previous research primarily focused on the heightened levels of depression due to COVID-19, our study offers a nuanced examination of diverse factors impacting mental health outcomes. We identify the multifaceted influences of various factors, elucidating both their detrimental effects and potential mitigating factors.

This paper is organized as follows, comprising three subsequent sections. Section 2 presents an introduction to the sample and provides descriptive statistics based on our findings. In Section 3, we examine and compare the impacts of various factors on the mental health of rural residents in China both before and during the COVID-19 period, while also highlighting heterogeneity among different subgroups. Finally, Section 4 concludes the paper by summarizing our findings.

2. Data and methods

The dataset employed in this study consists of two-year panel data collected in 2019 and 2020. In 2019, a stratified random sampling method was employed, encompassing locations such as Zhejiang Province, Yunnan Province, as well as the Huang-Huai-Hai Region, which includes Henan, Shandong, and Anhui provinces. Counties within each province were randomly selected, followed by the random selection of villages within each county. Ultimately, a sample of 152 villages was randomly chosen. Within each village, the sampling of rural residents was conducted randomly, selecting 10 households per village. However, based on contextual factors such as village size and residents' willingness to participate in the research, certain adaptations were made in specific villages. As a result, there were 21 villages with only 1 household, 4 villages with 2 households, 1 village with 4 households, 1 village with 6 households, 5 villages with 7 households, 3 villages with 8 households, 11 villages with 9 households, 92 villages with 10 households, 7 villages with 11 households, and 4 villages with 4 households. Moreover, within each household, a deliberate selection process was employed to identify one respondent, with a preference for inviting the head of the household, as the inclusion of questions related to agricultural production decisions in the questionnaire justified their participation. Consequently, a total of 1272 observations were obtained for the year 2019. Geographically, the sample included 360 individuals from Zhejiang Province, 478 individuals from Yunnan Province, and 434 individuals from the Huang-Huai-Hai Region. In 2020, the survey successfully tracked and maintained contact with 676 respondents through telephone calls. This included 177 individuals from Zhejiang Province, 231 individuals from Yunnan Province, and 268 individuals from the Huang-Huai-Hai Region.

The 2019 questionnaire was designed to collect comprehensive information from rural residents. It encompassed various aspects, including individual and household characteristics, as well as inquiries regarding their psychological status, mobile phone usage, and interactions within social messaging networks. Individual characteristics covered gender, age, education, and health-related

Table 1
Summary statistics.

Variables	Variable definition	Obs	2019 Mean	SD	2020 Mean	SD	Difference 2020–2019
Panel A: Psychological status							
CESD	CES-D-10 (the 10-item Center for the Epidemiological Studies of Depression Short Form) scores	676	4.32	4.085	3.61	4.319	−0.71***
Depression	Dummy; 1 = CESD ≥10; 0 = CESD <10	676	0.09	–	0.08	–	0.01
Panel B: Individual characteristics and family backgrounds							
Gender	Dummy; 1 = male; 0 = female	676	0.79	–	–	–	–
Age	Age	676	53.88	11.286	54.88	11.286	–
Education	Educational years	676	8.47	3.491	–	–	–
Health	Health status, 5-point Likert scale	676	4.09	1.021	–	–	–
Income	Per capita net household income in 2018, yuan	676	1.69	2.788	–	–	–
Number of families	The number of families	676	4.46	1.916	–	–	–
Panel C: Social communication network							
Number of friends	The number of friends	676	17.54	21.310	–	–	–
Trust in friends	Scale of trust in friends; 10-point Likert scale	676	8.73	1.664	–	–	–
Number of relatives	The number of relatives	676	20.28	31.225	–	–	–
Trust in relatives	Scale of trust in relatives; 10-point Likert scale	676	9.14	1.219	–	–	–
Number of Wechat contacts	The number of Wechat contacts	676	130.73	233.278	–	–	–
Panel D: COVID-19-related information							
Knowledge of COVID-19 virus transmission and prevention	Scale of knowledge of COVID-19 virus transmission and prevention, 10-point Likert scale	676	–	–	7.81	2.472	–
Isolation	Dummy; 1 = experienced isolation at home or quarantine sites; 0 = no home isolation or quarantine site isolation experience	676	–	–	0.06	0.242	–
Concern about COVID-19 infection	Scale of concern about COVID-19 infection, 10-point Likert scale	676	–	–	3.19	3.987	–

Data source: author's survey

information. Family information included the number of family members and the annual net household income, which enabled the calculation of per capita annual income. To assess rural residents' psychological status, the questionnaire incorporated the 10-item Center for the Epidemiological Studies of Depression Short Form (CES-D-10). This widely utilized scale comprises 10 questions, scored on a scale from 0 to 3. The CES-D has demonstrated validity and internal consistency in detecting both clinical and non-clinical depressive symptoms, making it a reliable and valid measure of depression in community and population-based epidemiological studies [39]. Its suitability for the Chinese population has also been established [40]. The questionnaire also included questions about social networks, covering the number of friends, level of trust in friends, number of relatives, and level of trust in relatives. For clarification, relatives were defined as individuals connected by blood or marriage, while the term "relatives" encompassed second-degree relatives (e.g., grandparents, uncles), third-degree relatives (e.g., great-grandparents, great uncles), and fourth-degree relatives (e.g., great-great-grandparents). Friends were defined as individuals connected through feelings of affection or personal regard, with frequent contact. Furthermore, the questionnaire inquired about mobile phone usage, specifically whether participants used WeChat, a popular social messaging app in China, and the number of WeChat contacts they had.

In the subsequent survey carried out in 2020, we maintained the same set of 10 questions as outlined in the CES-D-10 questionnaire. Furthermore, we incorporated a supplementary set of inquiries concerning the COVID-19 pandemic. These included assessing the respondents' knowledge of COVID-19, whether they had previously undergone isolation at home or at quarantine sites, as well as their concerns pertaining to potential infection.

The statistical summary of all 676 rural individuals successfully tracked in 2020 is presented in Table 1. The table reveals an overall improvement in the psychological status of rural residents. The top panel of Table 1 indicates that the average CES-D-10 score, which reflects the severity of depression (with higher scores indicating greater levels of depression), exhibited a significant decrease from 4.32 in 2019 to 3.61 in 2020, as confirmed by the *t*-test presented in the final column. Additionally, depression was defined based on the CES-D-10 cut-off score of 10 or higher, which indicates significant depressive symptoms. To be more specific, individuals will be categorized as having significant depressive symptoms if their CES-D-10 score is greater than or equal to 10. In such cases, the variable "depression" will be assigned a value of 1 to indicate the presence of significant depressive symptoms. Likewise, individuals will be classified as not having significant depressive symptoms if their CES-D-10 score is below 10. In these instances, the variable "depression" will be assigned a value of 0 to indicate the absence of significant depressive symptoms. Therefore, the variable "depression" is characterized as a dummy variable, with its mean value representing the percentage of individuals whose variable value is 1. On average, 9 % of rural residents reported suffering from depression in 2019, whereas this percentage decreased to 8 % in 2020. However, it is important to note that even though there was a slight improvement in rural residents' psychological status in 2020, this does not imply that the COVID-19 pandemic had no impact on their well-being. The observed improvements in psychological status among rural residents could be influenced by various time-varying factors, such as improvements in their income, living conditions, and other related aspects.

In terms of the individual characteristics and family backgrounds of rural residents, as indicated in Panel B, a majority of the sample (approximately 79 %) consisted of males. This distribution is primarily due to the inclusion of questions regarding agricultural production decisions in the questionnaire, which typically led to the head of the household being invited as the respondent. The average age of the respondents was 53.88 years, with an average educational attainment of 8.47 years. Health status was assessed on a 5-point Likert scale, with an average score of 4.09 indicating a moderate level of self-perceived health (where 1 represents "not at all healthy"

Table 2
Summary statistics: lower CES-D-10 score versus higher CES-D-10 score.

	2019			2020		
	Lower CES-D-10 score	Higher CES-D-10 score	Difference	Lower CES-D-10 score	Higher CES-D-10 score	Difference
Variables	Mean (1)	Mean (2)	Mean (1)-Mean (2)	Mean (1)	Mean (2)	Mean (1)-Mean (2)
Observations	265	411		335	341	
Gender	0.85	0.76	0.086***	0.82	0.76	0.061**
Age	54.05	53.78	0.267	54.29	55.46	−1.171
Education	8.83	8.24	0.586**	8.92	8.03	0.896***
Health	4.25	3.99	0.255***	4.23	3.96	0.271***
Income	1.59	1.60	−0.007	1.59	1.60	−0.010
Number of families	4.63	4.36	0.275*	4.46	4.46	−0.001
Number of friends	15.95	18.56	−2.615	19.13	15.915.977	3.155*
Trust in friends	9.08	8.50	0.581***	8.87	8.59	0.277**
Number of relatives	20.25	20.30	−0.045	20.52	20.05	0.465
Trust in relatives	9.29	9.05	0.238**	9.22	9.06	0.162*
Number of Wechat contacts	131.45	130.27	1.183	135.49	126.05	9.435
Knowledge of COVID-19 virus transmission and prevention				8.23	7.40	0.829***
Isolation				0.03	0.097	−0.070***
Concern about COVID-19 infection				2.89	3.49	−0.598*

Note: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
Data source: author's survey

and 5 represents "very healthy"). The average per capita net household income in 2018 was 16,900 yuan, equivalent to $2370. Additionally, the average number of family members per household was 4.46. Moving to Panel C, it focuses on social network statistics. On average, rural residents reported having a greater number of relatives (including second-degree, third-degree, and fourth-degree relatives) compared to the number of friends (defined by emotional connection or personal regard). The average number of friends was 17.54, while the average number of relatives was 20.28. Similarly, the average level of trust in relatives was higher compared to trust in friends, with an average trust score of 9.14 for relatives and 8.73 for friends. Finally, Panel D presents COVID-19-related information, highlighting the significant impact of the pandemic on people's lives. As of August 2020, approximately 6 % of rural residents had already been asked to isolate either at home or in designated quarantine sites. The summary statistics reveal that responses to the question assessing individual "concern about COVID-19 infection" produced a standard deviation of 3.19 points on a 10-point Likert scale. This indicates significant variability in rural residents' levels of personal fear regarding potential COVID-19 infection. While some respondents reported no concern at all, others expressed high levels of apprehension. Moreover, most rural residents considered themselves to possess a high level of knowledge about the transmission and prevention of COVID-19.

We further divided rural residents into two groups based on their CES-D-10 scores and conducted t-tests to compare the groups. The division was made using the median score, which remained the same in both 2019 and 2020. The group with a CES-D-10 score equal to or below the median was referred to as the "lower CES-D-10 score" group, while the group with a CES-D-10 score above or equal to the median was labeled as the "higher CES-D-10 score" group. Table 2 presents the characteristics of individuals in these two groups, along with the results of the t-tests examining the differences between them. As indicated in the third and last columns of Table 2, the first group (rural residents with lower CES-D-10 scores) exhibited significantly higher levels of education and better health status. However, there were no significant differences in age or per capita net household income between the two groups. Prior to the COVID-19 outbreak, the number of family members was significantly higher in the first group, but this difference did not persist during the pandemic. Additionally, in 2019, before the COVID-19 pandemic, there were no significant differences in the number of friends or relatives between the two groups. However, during the COVID-19 pandemic, rural residents with lower CES-D-10 scores had significantly more friends, and although the difference in the number of relatives was not significant, it showed a similar trend. Furthermore, both trust in friends and trust in relatives were significantly higher in the first group, both before and after the COVID-19 outbreak. Notably, during the COVID-19 pandemic, individuals with lower CES-D-10 scores demonstrated greater knowledge about COVID-19 virus transmission and prevention, as well as a lower level of concern about COVID-19 infection. These differences were statistically significant. In general, the proportion of individuals who had experienced isolation and lockdown was lower in the group with lower CES-D-10 scores, although the difference in the latter case was not statistically significant.

3. Econometric model

3.1. Factors influencing rural residents' depression before and during COVID-19

Firstly, we define an Ordinary Least Squares (OLS) model (1) using the 2019 data to examine the impact of gender, age, education, health, income, social network, and other factors on rural residents' depression:

$$CESD_{2019} = \beta_0 + \beta_1 P + \beta_2 H + \beta_3 S + \varepsilon_i \tag{1}$$

where $CESD_{2019}$ denotes the CES-D-10 score of rural residents in 2019, and P denotes personal characteristic such as gender and age. H represents family backgrounds such as income and family size, while S represents social interaction such as the number of friends and relatives, as well as the level of trust in them. Additionally, it includes the number of WeChat contacts.

Subsequently, we define another OLS model (2) where we change the dependent variable to $CESD_{2020}$ based on the model (1) to compare the influences of these independent variables before and during the COVID-19 by comparing $\beta_1, \beta_2, \beta_3$ with $\delta_1, \delta_2, \delta_3$.

$$CESD_{2020} = \delta_0 + \delta_1 P + \delta_2 H + \delta_3 S + \epsilon_i \tag{2}$$

Moreover, to study the effect of factors related to the COVID-19 epidemic, such as knowledge of COVID-19 virus transmission and prevention, experience of home isolation or quarantine, and the level of concern about COVID-19 infection, we introduce these variables to model (2):

$$CESD_{2020} = \gamma_0 + \gamma_1 P + \gamma_2 H + \gamma_3 S + \gamma_4 COVID + u_i \tag{3}$$

where *COVID* represents factors related to the COVID-19 epidemic. We will analyze the coefficient γ_4 to examine how COVID-19 affects the psychology of rural residents.

Finally, to estimate the impact of various factors on rural residents' depression during the epidemic in a more unbiased manner, we establish model (4) by including $CESD_{2019}$ as an independent variable. This allows us to control for the influence of unobservable factors that do not change over time:

$$CESD_{2020} = \alpha_0 + \alpha_1 P + \alpha_2 H + \alpha_3 S + \alpha_4 COVID + \alpha_5 CESD_{2019} + v_i \tag{4}$$

3.2. Moderated factors influencing the impact of concern about COVID-19 infection on rural residents' depression during COVID-19

Based on the results of models (1)–(4), we have identified concern about COVID-19 infection as a significant factor contributing to

rural residents' depression. In order to understand the factors that moderate the influence of concern about COVID-19 infection on rural residents' depression during COVID-19, we have constructed the following models by introducing interactive variables in addition to model (4):

$$CESD_{2020} = \lambda_0 + \lambda_1 P + \lambda_2 H + \lambda_3 S + \lambda_4 COVID + \lambda_5 CESD_{2019} + \lambda_6 Co \times P + \varsigma_i \tag{5}$$

$$CESD_{2020} = \eta_0 + \eta_1 P + \eta_2 H + \eta_3 S + \eta_4 COVID + \eta_5 CESD_{2019} + \eta_6 Co \times COVID + \tau_i \tag{6}$$

where $Co \times P$ in the model (5) represents the interaction between the variable "Concern about COVID-19 infection" and a series of variables related to personal characteristics. This allows us to examine the moderated effect of personal characteristics on the impact of "Concern about COVID-19 infection" on depression. In model (6), $Co \times COVID$ denotes the interaction between the variable "Concern about COVID-19 infection" and other factors related to COVID-19, such as "Isolation" and "Knowledge of COVID-19 virus transmission and prevention". This enables us to investigate whether these factors exacerbate or mitigate the impact of "Concern about COVID-19 infection" on psychological well-being.

Besides, in order to enhance the comprehensibility of Model (5) and Model (6), we elucidate their concepts through the inclusion of Fig. 1, which serves as a visual representation of the aforementioned models.

4. Results and discussion

4.1. Factors influencing rural residents' depression before and during COVID-19

In Table 3, we present the results of the factors influencing rural residents' depression before and during COVID-19, obtained by estimating Eq. (1), Eq. (2), Eq. (3) and Eq. (4).

Consistent with prior research, the findings in Column 1 reveal that prior to the epidemic, being female and having poor health status significantly contributed to higher levels of depression among rural residents [12,13,25]. Surprisingly, income and the proportion of non-agricultural income were found to significantly increase depression among rural inhabitants before COVID-19. It is worth noting that studies have argued that high income may lead to life satisfaction but not necessarily happiness, and emotional well-being tends to rise with logarithmic income [41]. Regarding social interactions, the level of trust in friends and the number of relatives were found to significantly decrease the CES-D-10 scores of rural residents.

In Column 2, the independent variables remain the same as in Column 1, but the dependent variable changes from the CES-D-10 score in 2019 to the CES-D-10 score in 2020. By comparing the coefficients between Column 1 and Column 2, we can observe the changes in personal, family, and social characteristics influencing rural residents' depression before and during the COVID-19 period.

Surprisingly, the gender difference in psychological well-being during the epidemic is no longer significant, and the absolute value of the coefficient greatly decreases. Considering that previous studies have identified family roles, such as differences in child care responsibilities between males and females [14], and the increased time spent at home by males during the epidemic, we argue that the COVID-19 pandemic may have had a positive impact on women's psychological well-being, contrary to the suggestions of previous studies that it negatively affected women's psychology. Furthermore, education plays a more important and significant role in rural
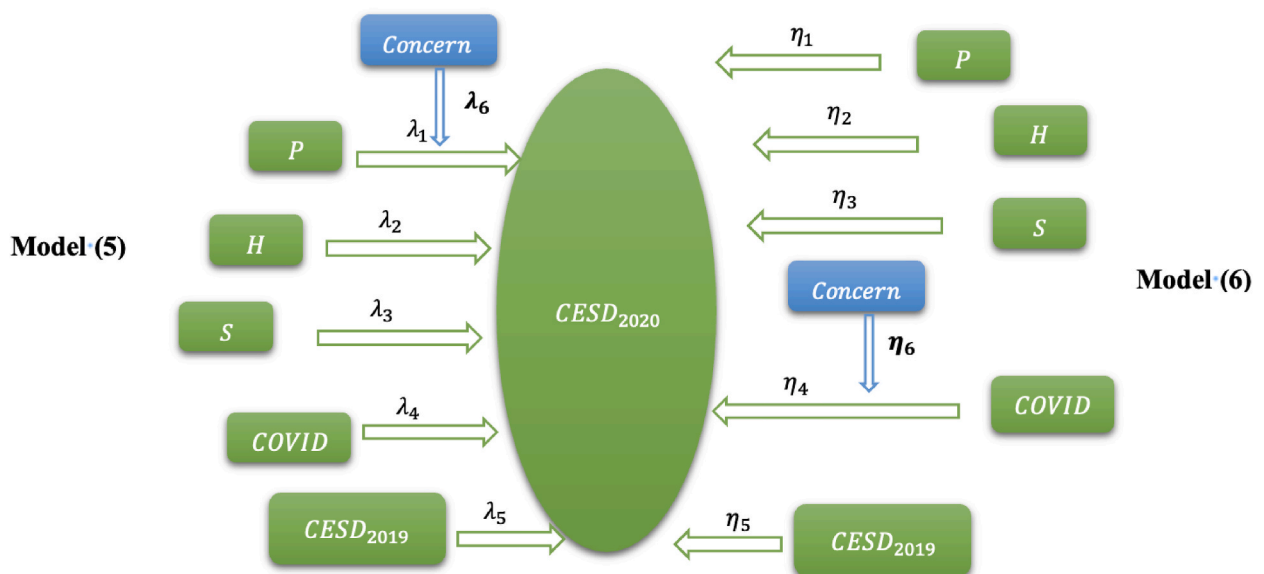

Fig. 1. Visual representation of model (5) and model (6).

Table 3
Factors influencing rural residents' depression before and during the COVID-19.

	(1)	(2)	(3)	(4)
	$CESD_{2019}$	$CESD_{2020}$	$CESD_{2020}$	$CESD_{2020}$
Gender	−1.257	−0.531	−0.234	0.035
	[−2.082,−0.431] **	[−2.407,1.345]	[−1.840,1.372]	[−1.681,1.751]
Age	−0.006	−0.024	−0.022	−0.020
	[−0.042,−0.029]	[−0.073,0.026]	[−0.060,0.017]	[−0.055,0.015]
Education	−0.111	−0.148	−0.100	−0.080
	[−0.271,0.050]	[−0.216,−0.080] ***	[−0.182,−0.019] **	[−0.186,0.027]
Health	−0.623	−0.912	−0.858	−0.714
	[−1.230,−0.015] **	[−1.448,−0.377] ***	[−1.343,−0.373] ***	[−1.071,−0.358] ***
Income	0.666	0.413	0.135	−0.006
	[0.117,1.216]**	[−0.034,0.860] *	[−0.481,0.752]	[−0.569,0.557]
Number of families	−0.098	−0.153	−0.161	−0.135
	[−0.292,0.097]	[−0.481,0.175]	[−0.454,0.132]	[−0.433,0.164]
Number of friends	0.006	−0.015	−0.016	−0.017
	[−0.005,0.017]	[−0.024,−0.007] ***	[−0.024,−0.007] ***	[−0.023,−0.011] ***
Trust in friends	−0.474	−0.233	−0.231	−0.116
	[−0.916,−0.033] **	[−0.293,−0.172] ***	[−0.341,−0.121] ***	[−0.210,−0.021] **
Number of relatives	−0.006	0.007	0.009	0.010
	[−0.010,−0.001] **	[−0.005,0.020]	[−0.005,0.023]	[−0.004,0.023]
Trust in relatives	−0.141	0.109	0.125	0.156
	[−0.495,0.212]	[−0.014,0.233] *	[−0.041,0.291]	[0.016,0.297]**
Number of Wechat contacts	0.000	0.001	0.001	0.001
	[−0.001,0.002]	[−0.001,0.002]	[−0.001,0.003]	[−0.001,0.003]
Knowledge of COVID-19 virus transmission and prevention			−0.254	−0.221
			[−0.343,−0.165] ***	[−0.307,−0.136]***
Isolation			2.193	2.063
			[0.710,3.676] **	[1.029,3.096] ***
Concern about COVID-19 infection			0.146	0.128
			[0.049,0.243] **	[0.042,0.215]**
$CESD_{2019}$				0.242
				[0.159,0.325]***
Constant	14.605	13.636	14.221	10.596
	[10.383,18.826] ***	[8.742,18.530] ***	[9.880,18.561] ***	[6.632,14.560] ***
City	Yes	Yes	Yes	Yes
Observations	676	676	676	676
R-squared	0.130	0.123	0.170	0.215
Adjusted R-squared	0.11	0.10	0.15	0.19

Note: Standard errors in parentheses are clustered at the city level.
Standard errors in parentheses, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
Data source: author's survey

residents' mental health. Additionally, both the number of friends and the level of trust in friends play a significant role in reducing rural residents' depression during COVID-19. However, the significance of the number of relatives diminishes, and the degree of trust in family members becomes significantly positive during the COVID-19 period.

Column (3) incorporated significant independent variables related to COVID-19. Our findings indicate that knowledge regarding COVID-19 virus transmission and prevention, the experience of home isolation or quarantine, and the level of concern regarding COVID-19 infection have a substantial impact on the depression levels of rural residents. Greater knowledge about COVID-19 virus transmission and prevention among rural residents is associated with a lower likelihood of experiencing depression. Additionally, the experience of being isolated at home or in quarantine sites significantly contributes to increased depression among rural residents. Furthermore, a heightened concern about COVID-19 infection also significantly amplifies depression levels in rural areas.

4.2. Moderating factors on the impact of concern about COVID-19 infection on depression among rural residents during the COVID-19 pandemic

Table 4 presents the results from model (5), illustrating the moderating effects of personal and family characteristics on the influence of concern about COVID-19 infection on depression among rural residents during the COVID-19 pandemic. Our findings indicate that both health status and the number of family members significantly mitigate the positive impact of concern about COVID-19 infection on rural residents' depression.

Furthermore, Table 5 reports the results from model (6), highlighting the moderating effects of epidemic-related factors on the influence of concern about COVID-19 infection on depression among rural residents during the COVID-19 pandemic. Our analysis reveals that the experience of isolation does not exert a significant influence on the impact of concern about COVID-19 infection on rural residents' depression during this period. However, a notable finding is that greater knowledge regarding COVID-19 virus transmission and prevention significantly diminishes the effect of concern about COVID-19 infection on rural residents' depression

Table 4

Moderated factors on the influence of concern about COVID-19 infection on rural residents' depression during COVID-19.

	(1)	(2)	(3)	(4)	(5)	(6)
	$CESD_{2020}$	$CESD_{2020}$	$CESD_{2020}$	$CESD_{2020}$	$CESD_{2020}$	$CESD_{2020}$
Gender	−0.295	0.051	0.048	0.141	0.042	0.005
	[−1.319,0.729]	[−1.63,1.73]	[−1.59,1.69]	[−1.61,1.89]	[−1.69,1.77]	[−1.67,1.68]
Age	−0.020	−0.028	−0.020	−0.019	−0.020	−0.021
	[−0.05,0.02]	[−0.07,0.01]	[−0.06,0.02]	[−0.06,0.02]	[−0.05,0.02]	[−0.06,0.01]
Education	−0.080	−0.080	−0.056	−0.081	−0.079	−0.080
	[−0.19,0.03]	[−0.19,0.03]	[−0.35,0.24]	[−0.17,0.01]*	[−0.18,0.03]	[−0.19,0.03]
Health	−0.721	−0.716	−0.713	−0.120	−0.715	−0.710
	[−1.09,-0.35]	[−1.07,-0.36]	[−1.06,-0.36]	[−0.29,0.05]	[−1.07,-0.36]	[−1.09,-0.33]
	***	***	***		***	***
Income	−0.014	−0.012	−0.017	−0.291	0.148	−0.014
	[−0.57,0.54]	[−0.59,0.56]	[−0.52,0.49]	[−0.89,0.31]	[−0.45,0.75]	[−0.60,0.57]
Number of families	−0.130	−0.133	−0.135	−0.124	−0.134	−0.005
	[−0.41,0.15]	[−0.43,0.17]	[−0.43,0.16]	[−0.44,0.20]	[−0.43,0.16]	[−0.37,0.36]
Number of friends	−0.017	−0.017	−0.017	−0.015	−0.017	−0.018
	[−0.02,-0.01]	[−0.02,-0.01]	[−0.02,-0.01]	[−0.02,-0.01]	[−0.02,-0.01]	[−0.02,-0.01]
	***	***	***	***	***	***
Trust in friends	−0.114	−0.118	−0.113	−0.112	−0.117	−0.112
	[−0.20,-0.02]**	[−0.21,-0.03]**	[−0.23,0.00]*	[−0.23,0.01]*	[−0.21,-0.02]**	[−0.21,-0.01]**
Number of relatives	0.010	0.010	0.010	0.009	0.010	0.010
	[−0.00,0.02]	[−0.00,0.02]	[−0.00,0.02]	[−0.00,0.02]	[−0.00,0.02]	[−0.00,0.02]
Trust in relatives	0.162	0.158	0.159	0.143	0.160	0.159
	[0.01,0.31]**	[0.02,0.30]**	[0.02,0.29]**	[−0.04,0.33]	[0.02,0.30]**	[0.01,0.30]**
Number of Wechat contacts	0.001	0.001	0.001	0.001	0.001	0.001
	[−0.00,0.00]	[−0.00,0.00]	[−0.00,0.00]	[−0.00,0.00]	[−0.00,0.00]	[−0.00,0.00]
Knowledge of COVID-19 virus transmission and prevention	−0.220	−0.223	−0.225	−0.228	−0.221	−0.222
	[−0.31,-0.13]	[−0.31,-0.14]	[−0.32,-0.13]	[−0.29,-0.16]	[−0.31,-0.14]	[−0.31,-0.14]
	***	***	***	***	***	***
Isolation	2.082	2.092	2.057	1.979	2.067	2.038
	[1.02,3.15]***	[1.09,3.09]***	[0.99,3.13]***	[0.77,3.19]**	[1.04,3.10]***	[1.00,3.08]***
Concern about COVID-19 infection	0.058	0.004	0.190	0.804	0.340	0.292
	[−0.24,0.35]	[−0.18,0.19]	[−0.39,0.77]	[0.60,1.01]***	[−0.39,1.07]	[0.06,0.52]**
Concern about COVID-19 infection* Gender	0.090					
	[−0.20,0.38]					
Concern about COVID-19 infection * Age		0.002				
		[−0.00,0.01]				
Concern about COVID-19 infection * Education			−0.008			
			[−0.07,0.06]			
Concern about COVID-19 infection * Health				−0.166		
				[−0.22,-0.11]		
				***		
Concern about COVID-19 infection * Income					−0.134	
					[−0.59,0.32]	
Concern about COVID-19 infection * Number of families						−0.036
						[−0.07,-0.00]**
CESD2019	0.247	0.241	0.239	0.233	0.241	0.244
	[0.17,0.33]***	[0.16,0.32]***	[0.17,0.31]***	[0.16,0.31]***	[0.16,0.32]***	[0.16,0.33]***
Constant	8.342	8.627	8.008	6.232	7.947	7.674
	[4.55,12.13]	[5.00,12.25]	[3.62,12.40]	[3.59,8.87]***	[4.68,11.21]	[4.19,11.16]
	***	***	***		***	***
City	Yes	Yes	Yes	Yes	Yes	Yes
Observations	676	676	676	676	676	676
R-squared	0.216	0.215	0.215	0.241	0.215	0.219
Adjusted R-squared	0.19	0.19	0.19	0.22	0.19	0.20

Note: Standard errors in parentheses are clustered at the city level.

Standard errors in parentheses, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Data source: author's survey

during the COVID-19 pandemic.

5. Conclusion

5.1. Important findings

In this study, we conducted an investigation into the factors influencing depression among rural residents before and during the COVID-19 pandemic, utilizing panel data collected in two waves (pre- and post-outbreak of COVID-19). The findings from OLS

Table 5
Moderated factors on the influence of concern about COVID-19 infection on rural residents' depression during COVID-19.

	(1) CESD$_{2020}$	(2) CESD$_{2020}$
Gender	0.043	0.037
	[-1.69,1.77]	[-1.67,1.75]
Age	−0.019	−0.020
	[-0.05,0.01]	[-0.05,0.01]
Education	−0.078	−0.082
	[-0.18,0.02]	[-0.19,0.03]
Health	−0.707	−0.713
	[-1.05,-0.36]***	[-1.06,-0.37]***
Income	0.001	0.006
	[-0.55,0.55]	[-0.55,0.56]
Number of families	−0.133	−0.138
	[-0.43,0.16]	[-0.44,0.16]
Number of friends	−0.017	−0.017
	[-0.02,-0.01]***	[-0.02,-0.01]***
Trust in friends	−0.112	−0.115
	[-0.20,-0.02]**	[-0.21,-0.02]**
Number of relatives	0.010	0.010
	[-0.00,0.02]	[-0.00,0.02]
Trust in relatives	0.159	0.150
	[0.02,0.30]**	[0.00,0.30]**
Number of Wechat contacts	0.001	0.001
	[-0.00,0.00]	[-0.00,0.00]
Knowledge of COVID-19 virus transmission and prevention	−0.221	−0.184
	[-0.31,-0.14]***	[-0.27,-0.10]***
Isolation	1.584	2.059
	[-0.90,4.07]	[1.04,3.08]***
Concern about COVID-19 infection	0.121	0.235
	[0.04,0.20]**	[0.09,0.38]**
Concern about COVID-19 infection * Isolation	0.153	
	[-0.41,0.71]	
Concern about COVID-19 infection * Knowledge of COVID-19 virus transmission and prevention		−0.013
		[-0.02,-0.00]**
CESD2019	0.243	0.240
	[0.16,0.32]***	[0.16,0.32]***
Constant	8.011	7.932
	[5.09,10.93]***	[4.48,11.38]***
City	Yes	Yes
N	676	676
R2	0.216	0.216
Adj. R2	0.19	0.19

Note: Standard errors in parentheses are clustered at the city level.
Standard errors in parentheses, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
Data source: author's survey

regression analysis revealed that, prior to COVID-19, gender, health, per capita net household income, the level of trust in friends, and the number of relatives significantly influenced rural residents' depression. However, during the COVID-19 period, gender no longer exhibited a significant impact, while education emerged as a significant factor influencing rural residents' depression. Regarding social networks, both the number and level of trust in friends exhibited a significant decrease in rural residents' depression. Conversely, the significance of the number of relatives diminished, and the level of trust in relatives played a significantly positive role in depression. Furthermore, epidemic-related factors, including knowledge of COVID-19 virus transmission and prevention, experience of isolation, and the level of concern about COVID-19 infection, significantly influenced rural residents' depression during the pandemic. We also examined moderating factors by introducing an interaction variable between "Concern about COVID-19 infection" and other factors, which impacted the influence of the scale of concern about COVID-19 infection on rural residents' depression. Our findings indicated that rural residents' health status, number of family members, and knowledge of COVID-19 virus transmission and prevention served as significant moderating factors affecting the influence of their concern about infection on depression.

5.2. Main conclusion

Overall, the study highlights the dynamic nature of factors influencing depression among rural residents before and during the COVID-19 pandemic. It demonstrates the shifting significance of certain variables and underscores the importance of considering contextual factors in understanding rural residents' mental well-being.

5.3. Policy implication

By discerning which factors yield what outcomes and identifying potential ameliorative measures, our study offers valuable guidance for policymakers seeking effective interventions. Firstly, there is a pressing need to allocate resources and support to individuals with lower education levels, as the study indicates their heightened vulnerability to depression. This can be achieved through the establishment of educational programs aimed at enhancing mental health literacy and providing coping strategies for this specific population.

Secondly, addressing the poor health statuses of rural residents should be a priority. Accessible healthcare services, including mental health services, should be made readily available to rural communities, ensuring that individuals receive proper care and treatment for both physical and mental health issues. Collaborative efforts between local healthcare providers and government agencies can help bridge the healthcare gap and promote holistic well-being among rural residents.

Furthermore, the study highlights the impact of isolation on rural residents' mental health. Therefore, it is crucial to combat social isolation by fostering social connections within rural communities. Community-based initiatives such as support groups, recreational activities, and information-sharing platforms can facilitate social interaction and create a sense of belonging, thus mitigating the negative effects of isolation.

In addition, policymakers should prioritize public education campaigns focused on disseminating accurate and up-to-date information about COVID-19 transmission and prevention. By enhancing rural residents' knowledge and understanding of the virus, misconceptions and fears can be addressed, leading to reduced anxiety and depression related to the pandemic. These campaigns can employ various mediums, including local media outlets, community meetings, and digital platforms accessible to rural populations.

Lastly, it is essential for policymakers to collaborate with relevant stakeholders, including community leaders, healthcare professionals, and mental health experts, to ensure the effective implementation of these recommendations. Continuous monitoring and evaluation of mental health programs and initiatives can help identify areas of improvement and inform future policy decisions to better support the psychological well-being of rural residents during and beyond the COVID-19 pandemic.

Data availability statement

Data associated with the study has not been deposited into a publicly available repository. Data are available from the corresponding author on reasonable request.

Ethical approval

The study received ethical approval from the China Agricultural University Institutional Review Board. All procedures performed in studies involving human participants followed the 1964 Helsinki Declaration and its later amendments. The patients/participants provided their written informed consent to participate in this study.

CRediT authorship contribution statement

Ruotong Li: Writing – review & editing, Writing – original draft, Validation, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Qiran Zhao:** Writing – review & editing, Visualization, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Data curation. **Yi Cui:** Supervision, Investigation, Data curation. **Shenggen Fan:** Supervision, Resources, Project administration, Funding acquisition.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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References

[1] C.R. Snyder, S.J. Lopez, Handbook of Positive Psychology, Oxford University Press, 2001.
[2] M. Prince, V. Patel, S. Saxena, M. Maj, J. Maselko, M.R. Phillips, A. Rahman, No health without mental health, Lancet 370 (2007) 859–877, https://doi.org/10.1016/S0140-6736(07)61238-0.
[3] R.W. Larson, D.M. Almeida, Emotional transmission in the daily lives of families: a new paradigm for studying family process, J. Marriage Fam. 61 (1999) 5, https://doi.org/10.2307/353879.
[4] Y. Gu, Mental health, cognitive ability and family income—empirical analysis based on the follow-up survey of Chinese households, MATEC Web of Conferences 359 (2022), https://doi.org/10.1051/matecconf/202235901034.
[5] M. Davlasheridze, S.J. Goetz, Y. Han, The effect of mental health on US county economic growth, RRS 48 (2018) 155–171, https://doi.org/10.52324/001c.7997.
[6] D. Vigo, G. Thornicroft, R. Atun, Estimating the true global burden of mental illness, Lancet Psychiatr. 3 (2016) 171–178, https://doi.org/10.1016/S2215-0366(15)00505-2.
[7] F.K. Judd, H.J. Jackson, A. Komiti, G. Murray, G. Hodgins, C. Fraser, High prevalence disorders in urban and rural communities, Aust. N. Z. J. Psychiatr. 36 (2002) 104–113, https://doi.org/10.1046/j.1440-1614.2002.00986.x.
[8] M. Fu, J. Guo, Z. Qu, Z. Han, S. Wang, H. He, Long-term health consequences among Wenchuan earthquake adult survivors: implications of a framework for postearthquake reconstruction, J. Nerv. Ment. Dis. 207 (2019) 884–892.
[9] W. Shi, Z. Shen, S. Wang, B.J. Hall, Barriers to professional mental health help-seeking among Chinese adults: a systematic review, Front. Psychiatr. 11 (2020) 442, https://doi.org/10.3389/fpsyt.2020.00442.
[10] X. Fu, kan Zhang, zhiyan Chen, X. Chen, Report on National Mental Health Development in China (2017–2018), Institute of Psychology, Chinese Academy of Sciences and other departments, Beijing, 2019.
[11] X. Fu, kan Zhang, X. Chen, zhiyan Chen, Report on National Mental Health Development in China (2019-2020), Institute of Psychology, Chinese Academy of Sciences and Other Departments, Beijing, 2021 book.duxiu.com/bookDetail.jsp?dxNumber=000019341304&d=26CA065D6B72F439105892929D4FF31B&fenlei=16061106&sw=%E3%80%8A%E4%B8%AD%E5%9B%BD%E5%9B%BD%E6%B0%91%E5%BF%83%E7%90%86%E5%81%A5%E5%BA%B7%E5%8F%91%E5%B1%95%E6%8A%A5%E5%91%8A%EF%BC%882019-2020%EF%BC%89%E3%80%8B (accessed August 29, 2022).
[12] M.G. Cole, N. Dendukuri, Risk factors for depression among elderly community subjects: a systematic review and meta-analysis, Am. J. Psychiatr. 160 (2003) 1147–1156.
[13] M. Luppa, C. Sikorski, T. Luck, L. Ehreke, A. Konnopka, B. Wiese, S. Weyerer, H.-H. König, S.G. Riedel-Heller, Age-and gender-specific prevalence of depression in latest-life–systematic review and meta-analysis, J. Affect. Disord. 136 (2012) 212–221.
[14] P. Bebbington, The origins of sex differences in depressive disorder: bridging the gap, Int. Rev. Psychiatr. 8 (1996) 295–332.
[15] J.A. Baldwin, Five-year incidence of reported psychiatric disorder, Int. Psychiatr. Clin. 8 (1971) 39–60.
[16] P.E. Bebbington, E. Sturt, C. Tennant, J. Hurry, Misfortune and resilience: a community study of women, Psychol. Med. 14 (1984) 347–363.
[17] J.G. de Alarcón, P. Sainsbury, W.R. Costain, Incidence of referred mental illness in Chichester and Salisbury, Psychol. Med. 5 (1975) 32–54.
[18] W.M. Ensel, The role of age in the relationship of gender and marital status to depression, J. Nerv. Ment. Dis. 170 (1982) 536–543.
[19] P.E. Bebbington, C. ea Dean, G. Der, J. Hurry, C. Tennant, Gender, parity and the prevalence of minor affective disorder, Br. J. Psychiatr. 158 (1991) 40–45.
[20] D.G. Blazer, Depression in late life: review and commentary, The Journals of Gerontology Series A: Biological Sciences and Medical Sciences 58 (2003) M249–M265.
[21] A. Di Florio, K. Putnam, M. Altemus, G. Apter, V. Bergink, J. Bilszta, R. Brock, A. Buist, K.M. Deligiannidis, E. Devouche, The impact of education, country, race and ethnicity on the self-report of postpartum depression using the Edinburgh Postnatal Depression Scale, Psychol. Med. 47 (2017) 787–799.
[22] R.A. Miech, M.J. Shanahan, Socioeconomic status and depression over the life course, J. Health Soc. Behav. (2000) 162–176.
[23] M. Nyandra, B.H. Kartiko, P.C. Susanto, A. Supriyati, W. Suryasa, Education and training improve quality of life and decrease depression score in elderly population, education and training improve quality of life and decrease depression score in elderly population, Eurasian Journal of Analytical Chemistry 13 (2018).
[24] J. Lee, Pathways from education to depression, J. Cross Cult. Gerontol. 26 (2011) 121–135.
[25] G. Verropoulou, C. Tsimbos, Socio-demographic and health-related factors affecting depression of the Greek population in later life: an analysis using SHARE data, Eur. J. Ageing 4 (2007) 171–181.
[26] B.S. Frey, A. Stutzer, What can economists learn from happiness research? J. Econ. Lit. 40 (2002) 402–435.
[27] F.J. Zimmerman, W. Katon, Socioeconomic status, depression disparities, and financial strain: what lies behind the income-depression relationship? Health Econ. 14 (2005) 1197–1215.
[28] R.C. Kessler, R.H. Price, C.B. Wortman, Social factors in psychopathology: stress, social support, and coping processes, Annu. Rev. Psychol. 36 (1985) 531–572.
[29] R.L. Simons, F.O. Lorenz, C.-I. Wu, R.D. Conger, Social network and marital support as mediators and moderators of the impact of stress and depression on parental behavior, Dev. Psychol. 29 (1993) 368.
[30] R.P. Rajkumar, COVID-19 and mental health: a review of the existing literature, Asian Journal of Psychiatry 52 (2020) 102066, https://doi.org/10.1016/j.ajp.2020.102066.
[31] G. Ustun, Determining depression and related factors in a society affected by COVID-19 pandemic, Int. J. Soc. Psychiatr. 67 (2021) 54–63.
[32] R.C. Jiloha, COVID-19 and mental health, Epidemiology International 5 (2020) 7–9 (E-ISSN: 2455-7048).
[33] J.-B. Li, A. Yang, K. Dou, R.Y. Cheung, Self-control moderates the association between perceived severity of coronavirus disease 2019 (COVID-19) and mental health problems among the Chinese public, Int. J. Environ. Res. Publ. Health 17 (2020) 4820.
[34] J. Shigemura, R.J. Ursano, J.C. Morganstein, M. Kurosawa, D.M. Benedek, Public responses to the novel 2019 coronavirus (2019-nCoV) in Japan: mental health consequences and target populations, Psychiatr. Clin. Neurosci. 74 (2020) 281.
[35] J. Zhou, L. Liu, P. Xue, X. Yang, X. Tang, Mental health response to the COVID-19 outbreak in China, Am. J. Psychiatr. 177 (2020) 574–575.
[36] F. Chierichetti, S. Lattanzi, A. Panconesi, Rumor spreading in social networks, Theor. Comput. Sci. 412 (2011) 2602–2610.
[37] D.S. Mileti, L. Peek, The social psychology of public response to warnings of a nuclear power plant accident, J. Hazard Mater. 75 (2000) 181–194.
[38] H. Wang, M. Zhang, R. Li, O. Zhong, H. Johnstone, H. Zhou, H. Xue, S. Sylvia, M. Boswell, P. Loyalka, S. Rozelle, Tracking the effects of COVID-19 in rural China over time, Int. J. Equity Health 20 (2021) 35, https://doi.org/10.1186/s12939-020-01369-z.
[39] L.S. Radloff, The CES-D scale: a self-report depression scale for research in the general population, Appl. Psychol. Meas. 1 (1977) 385–401.
[40] K.W. Boey, Cross-validation of a short form of the CES-D in Chinese elderly, Int. J. Geriatr. Psychiatr. 14 (1999) 608–617, https://doi.org/10.1002/(SICI)1099-1166(199908)14:8<608::AID-GPS991>3.0.CO;2-Z.
[41] Daniel Kahneman, Angus Deaton, High income improves evaluation of life but not emotional well-being, Proc. Natl. Acad. Sci. USA 107 (2010) 16489–16493, 10.1073/pnas.1011492107.