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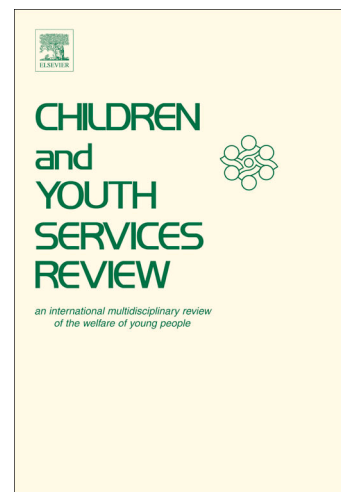
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Psychological Stress of University Students in the Hardest-hit Areas at Different Stages of the COVID-19 Epidemic

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Abstract

Background: The outbreak of COVID-19 has caused extremely many serious consequences for the country and the world. In fact, it has seriously affected people's mental health. The purpose of this study is to understand the psychological stress among college students in different stages of epidemics in hard-hit areas such as Hubei. Moreover, to highlight the factors that influencing, their psychological conditions with the emphasis of further corresponding suggestions.

Methods: This study includes self-designed questionnaires in order to assess and analyze the psychological state of over 17,000 college students during the outbreak period in January and home quarantine in February. The questionnaire contains three aspects and six dimensions: pressure responses: stress susceptibility (SS), stress adjustment (SA), risk cognition: cognition of danger (CD), cognition of illness (CI) and stress reactions: emotional responses (ER), somatic responses (SR). This survey was done by an online questionnaire (www.wjx.cn) to investigate the psychological stress information of college students, and analyzed the data by SPSS 22.0 for Windows.

Results: Regarding the stress susceptibility, participants were more likely stressed in February than in January. Regarding the stress adjustment, the number of participants requiring pressure regulation or release in the February survey was significantly lower than that the effective in the January survey. The mean of the cognition of danger reduced significantly in February than in January, in other words, participants were highly worried about the epidemic in January than in February. Regarding the

cognition of illness, participants in January had a more pessimistic attitude towards the epidemic than those in February. The emotional responses of the participants in February were more severe than those in January, while the somatic responses reduced significantly in February compared with January. Furthermore, females have stronger stress reactions than males. However, the SR doesn't have significant differences between females and males.

Conclusion: After two surveys in January and February, it was found that the psychological stress of college students in Hubei were significantly different at different stages of the epidemic, where the epidemic developed, the psychological stress of college students become more severe. The psychological stress of the college students in Hubei Province, as a severely affected area, should be paid more attention.

Keywords: COVID-19; Hubei Province; Epidemic; Different stages; Stress reaction

1. Introduction

Since December 2019, there has been a large-scale outbreak of the new coronavirus pneumonia (COVID-19) in Wuhan [1]. None of the 34 provincial administrative regions in the country have been spared, and patients with confirmed pneumonia have appeared in all regions [2]. The scale and severity of the pneumonia outbreak caused many cities, including Wuhan [3], to close, especially the prefecture-level cities in Hubei Province. Since the outbreak of the pneumonia, university students across the country have been trembling, few people are on the streets, and most of the shops are closed, which is unprecedented. This sudden public health incident has made Wuhan, Hubei, China the focus of the world [4]. On 11th February 2020, the World Health Organization (WHO) proposed the new coronavirus pneumonia named COVID-19.

Public health emergencies include major infectious disease outbreaks, mass unexplained diseases, major food and occupational poisoning and other events that cause or are likely to cause serious damage to and affect public health. The COVID-19 epidemic is a public health emergencies which has brought devastation to the entire world, relatively high rates of symptoms of anxiety (6.33% to 50.9%), depression (14.6% to 48.3%), posttraumatic stress disorder (7% to 53.8%), psychological distress (34.43% to 38%), and stress (8.1% to 81.9%) are reported in the general population during the COVID-19 pandemic in China, Spain, Italy, Iran, the US, Turkey, Nepal, and Denmark [5], as a result, the COVID-19 epidemic has had a significant impact on the mental health of people around the world. Other researchers have also shown that many people have been affected emotionally after the COVID-19 outbreak, during the initial phase of the COVID-19 outbreak in China, more than half of the respondents rated the psychological impact as moderate-to-severe, and about one-third reported moderate-to-severe anxiety, and students were found to experience a psychological impact of the outbreak and higher levels of stress, anxiety, and depression than adults [6]. Some researchers have revealed similar pattern, they identified the specific target groups (young and students)

prone for the psychological impact of the current COVID-19 outbreak in China [7]. China divides events into four levels according to the severity of the event, and this COVID-19 is a particularly significant level I event. China has moved quickly to contain the outbreak [8]. Live animal markets throughout the country have been suspended [9].

Previous studies showed that public events would devastate communities in terms of lives and property, and they are difficult to recover from without help. For example, a study of PTSD after earthquake over half of people exhibited internalizing problems requiring clinical intervention [10]. In a recent study on the new crown epidemic, it was shown that during the outbreak of COVID-19, for the population, severe PTSD has also emerged, with 10.8% of workers experiencing psychological stress in a survey of returning workers [11], but the stress response of workers can be mitigated by personal protection and ensuring ventilation. While focusing on the stress response of the population, some researchers have also focused on the mentally ill. Are people who are already suffering from mental disorders suffering more negative effects than normal when exposed to a new epidemic? The answer is "yes". During the peak of the COVID-19 epidemic with strict lockdown measures, psychiatric patients scored significantly higher on the total IES-R, DASS-21 anxiety, depression, and stress subscales and, total ISI scores. More than onequarter of psychiatric patients reported PTSD-like symptoms and moderate to severe insomnia. Psychiatric patients were significantly more likely to report worries about their physical health, anger, impulsivity, and suicidal ideation [12]. During the SARS period in 2003, the disease caused more severe psychological stress reactions to the public. This time, the spread of the new coronavirus pneumonia was wider, the mortality rate was higher, the people were more panicked, and it was more likely to cause severe psychological stress. This study used a self-administered questionnaire intended to explore the participants' perceptions of the epidemic, their stress responses to the epidemic, and how they coped with the stress generated by the epidemic, we used specific

questionnaire questions to explore each of these three aspects. The survey was conducted from three aspects: pressure responses, risk cognition and stress reactions. We chose these three aspects because the three topics were mentioned most frequently by the college students in the pre-interviews, we considered the study variables mentioned more frequently in the interviews to be more meaningful. Therefore, we need to pay more attention to the PTSD caused by public health emergencies. In addition, some researchers pointed out that the optimization of the pain control may reduce the risk of the subsequent development of PTSD and be effective for the secondary prevention of PTSD [13].

It is well known that the COVID-19 is a devastating catastrophe worldwide, and other countries besides China have suffered from it. This is the first time in Vietnam that people have undergone “social distancing” to minimize the spreading of infectious disease, COVID-19. These deliberate preemptive strategies may have profound impacts on the mental health of the population [14]. A similar situation is also seen in the Philippines: 16.3% of respondents rated the psychological impact of the outbreak as moderate-to-severe; 16.9% reported moderate-to-severe depressive symptoms; 28.8% had moderate-to-severe anxiety levels; and 13.4% had moderate-to-severe stress levels [15].

Public events will cause psychological stress, a previous research found that participants were exposed to unprecedented horror and a serious stress response following the Indian Ocean tsunami in Khao Lak, Thailand [16], which is similar to the mechanism of development of this COVID-19 epidemic, they were sudden, natural and caused great harm, it can also influence the emotion. Although emotion is a subjective psychological reaction, it often affects people's external performance and people's cognition, in contemporary society, people are under great pressure, and crises such as this new coronavirus pneumonia are prone to cause psychological stress [17]. Some researchers [18] found that great psychological status can affect students' learning strategies to a certain extent.

Psychological research has also found that people usually experience four stages of contempt, panic, helplessness, and acceptance after a disaster. Especially in high-risk areas, the psychological stress of the population is more serious. People in the disaster-stricken areas are calmer and even despise those who are not [19]. With the development of the epidemic, people in disaster-stricken areas will experience several stages of panic, helplessness, and acceptance. To investigate the stress reaction of people in severely affected areas in different stages of the epidemic (outbreak period, isolation period, recovery period, and acceptance period), a questionnaire survey was conducted in the outbreak period in January and the isolation period in February.

This survey selected college students (age 18-30) as the research sample. College students are an important backbone of social development. Their psychological state affects the direction of social development, and the mental state of college students is easily affected [20], their psychological status is not stable [21]. Public health crisis events are sudden and unpredictable. The psychological stress reaction of university students is the focus of society. Before this survey, several scholars have investigated the social stress reaction after a public crisis event, but university students are rarely used as research samples, and so this investigation is necessary. We should focus on their mental health, and it deserves the attention of society.

2. Methods

2.1 Preparation of Stress Response Questionnaire

This survey utilized a self-designed questionnaire, we produced this questionnaire by following several steps: First, information was collected through small-scale interviews, the initial items were generated by interviewing a part of college students in Hubei, the interview relates to their psychological status and their disorders, for example, their awareness of the COVID-19, their current physical and emotional state whether they feel a lot of stress and whether they need help, etc. Next, after the interviews, the researchers sorted out the problems and mentioned disorders

mentioned by these college students, such as whether they were so afraid of being infected that they have trouble sleeping, and they thought the COVID-19 was hard to defeat, etc. Then we compiled a stress response questionnaire, and determined the questionnaire topics and factors using exploratory factor analysis (EFA). After constructing a stress reaction questionnaire with good reliability and validity, we used confirmatory factor analysis (CFA) to validate the validity of the questionnaire and to make the questionnaire reach the ideal standard. Finally, we obtained the final psychological stress questionnaire.

2.1.1 Exploratory Factor Analysis (EFA)

In the initial test, 32-item questionnaire was divided into three aspects (pressure response, risk cognition, and stress reaction) were collected for the exploratory factor analysis (EFA) through online questionnaires to determine the dimensions of the questionnaire. Among the 363 participants in the exploratory factor analysis, 223 were males and 140 were females, with an average age of 19.07 ± 0.08 . The results of the fitness test showed that the KMO value was 0.86, and the Chi-squared value of the Bartlett spherical test was 3000.58 ($df = 210, p < 0.001$), which proves that the exploratory factor analysis is feasible. Using the principal component extraction method (PCA) and the maximum variance method, we finally obtained 6 factors and a total of 21 items, and the items explained 64.57% of the variance in the results. The results are shown in Table 1. The factor loadings range is 0.45-0.87, indicating that the structural validity of the scale is acceptable. The six dimensions are then named cognition of danger (CD), cognition of illness (CI), emotional responses (ERs), somatic reactions (SRs), stress susceptibility (SS), and stress adjustment (SA).

INSERT TABLE 1 HERE

2.1.2 Reliability and validity analysis

SPSS 22.0 for Windows (SPSS Inc., Chicago, Illinois) was used to calculate the internal consistency reliability (Cronbach's α coefficient), split-half reliability, and the correlation between each factor score and the total score. The internal consistency reliability is 0.82.

2.1.3 Correlation analysis

To ensure the structural validity of the questionnaire, we conducted correlation analysis using the questionnaire and estimated the structural validity of the questionnaire based on the correlation between the dimensions. As can be seen from the table, the correlation coefficients between the dimensions of the questionnaire are less than 0.55, showing a moderate degree of correlation. It shows that there is a good degree of discrimination among the dimensions of this questionnaire, which indicates that there is a certain degree of independence between variables and that there is a certain relationship, which indicates that the structure of the questionnaire meets the basic requirements for questionnaire preparation. The results are shown in Table 2.

INSERT TABLE 2 HERE

2.1.4 Confirmatory factor analysis (CFA)

To verify the suitability of the ideal model with respect to the actual data, data from 461 participants (223 males and 238 females) were collected for confirmatory factor analysis (CFA). CFA establishes a latent variable model based on the results of the EFA. That is, the six dimensions are used as the latent variables to estimate each item

in the dimension, and each dimension is further classified into six sub-questionnaires to estimate the overall psychological stress questionnaire. The results of the model fitting index in this study show that $\chi^2 / df = 2.885$, CFI = 0.908, GFI = 0.894, NFI = 0.866, and RMSEA = 0.064, which meet the standard for a good model. Therefore, 21 items are in the confirmatory factor analysis. The constructed latent variable model fits the data well, as shown in Figure 1.

This self-made questionnaire can effectively measure the psychological stress response of university students (age 20.45 ± 1.84) in the face of public emergencies, including risk cognition, physiological stress response, stress adjustment, etc.

INSERT FIGURE 1 HERE

2.2 Samples of participants

A total of 20,280 questionnaires were collected using the final questionnaire survey. In the first survey, the second week after Wuhan was closed, that is, January 29–31, 2020, a total of 8,607 people filled out the questionnaire (age 19.56 ± 1.79 , 54.19% female) in Hubei, and in the second survey, in the fourth week, February 17–20, 2020, 21,581 questionnaires were collected, and 8,876 people around the Hubei province filled out the questionnaire (age 20.99 ± 2.19 , 57.59% female).

2.3 Procedures

The study was designed in accordance with the tenets of the Declaration of Helsinki. Approval from the ethical authority of School of Educational Science, Huazhong University of Science and Technology was granted. Confidentiality was managed by assigning anonymous codes to the self-report questionnaires. This survey used online questionnaire (www.wjx.cn) to investigate the psychological information of college

students in January and February [22, 23]. We distributed questionnaires online through Wechat, QQ, and Sina microblog. Participants provided informed consent, then provided socio-demographic information and completed measures of their psychological status.

2.4 Measures

Two surveys utilized the same questionnaires, the researchers eventually produced a questionnaire with 29 items. Then we used WeChat, online questionnaires and other online surveys to investigate the psychological situation of college students in Hubei. Socio-demographic information included: age, gender, marital status, education level, and physical conditions (Whether be infected with the NCP). The measurement questions included three dimensions: 1. pressure responses, it consisted of the stress susceptibility (SS) and the stress adjustment (SA), including 8 items; 2. Prisk cognition, it consisted of the cognition of danger (CD) and the cognition of illness (CI), including 5 items; 3. stress reactions, it consisted of the emotional responses (ER) and the somatic responses (SR), including 8 items. **2.5 Statistical analyses**

The statistical analyses were performed using SPSS 20.0 for Windows (SPSS Inc., Chicago, Illinois). The statistical methods and data analysis results are described in detail as follows. As for the survey used the online questionnaire (www.wjx.cn), we can choose to refuse any empty questions during the questionnaire preparation, so the survey can ensure that each questionnaire collected is valid.

3. Results

3.1 Differences in stress reactions at different stages of the epidemic

We used SPSS 22.0 for Windows (SPSS Inc., Chicago, Illinois) to conduct independent sample T-tests on the survey data of the participants in Hubei Province between January and February, and the results are shown in Table 3. Comparing January and February shows that the higher the average is, the more severe the stress

reaction. Next, we will explain in detail according to the three parts and six dimensions.

INSERT TABLE 3 HERE

3.1.1 Comparison of the pressure responses in Hubei

The aspect of pressure responses includes two variables: the stress susceptibility (SS) and the stress adjustment (SA), that are the independent sample T-tests for results of the two surveys done in January and February revealed that there are differences in these two variables between January and February. As shown in Table 3, regarding the SS, participants were more likely to feel stress in February than in January, such as the participants in February said it was more difficult to concentrate on anything other than viruses ($2.98 > 2.04, p < 0.001$) (Q27). Whereas participants in February were far more stressed than those in January ($3.46 > 2.51, p < 0.001$) (Q29). Regarding the SA, the number of participants requiring pressure regulation or release in the February survey was significantly lower than that in the January survey. Such as in detail, participants in the January survey indicated that they needed professional psychological counseling more than in February ($1.78 < 3.54, p < 0.001$) (Q21). Regarding the question of whether they need to talk with family and friends (Q22), the participants in January said they needed it more than in February ($2.37 < 3.14, p < 0.001$).

3.1.2 Comparison of risk cognition in Hubei

The aspect of risk cognition includes two variables: the cognition of danger (CD) and

the cognition of illness (CI). Regarding the risk cognition, there were significant differences between January and February in the CD and the CI. The same independent sample T-test indicated that the mean of the CD reduced significantly in February than in January, in other words, participants were worried about the epidemic in January than in February. Such as participants in January considered the epidemic to be more serious, while participants in February were more optimistic ($3.69 < 4.32, p < 0.001$) (Q9). Regarding the CI, participants in January had a more pessimistic attitude towards the epidemic than those in February by thinking that it was dangerous ($2.98 > 2.74, p < 0.001$) (Q10) and likely to get sick ($2.57 > 2.36, p < 0.001$) (Q11). They believed that the COVID-19 could not be cured, but the answers to these questions were different in February in which the attitudes became more positive ($1.77 < 1.99, p < 0.001$) (Q28).

3.1.3 Comparison of stress reactions in Hubei

Regarding stress reactions, the results for the emotional responses (ER) and somatic responses (SR) between January and February are quietly different. The ER of the participants in February were more severe than those in January, while the SR reduced significantly in February compared with January. Regarding the ER, negative emotions such as nervousness (Q13, $2.10 > 1.62, p < 0.001$), fear (Q14, $1.94 > 1.41, p < 0.001$), terror (Q15, $2.01 > 1.62, p < 0.001$), depression (Q16, $2.10 > 1.54, p < 0.001$), and anxiety (Q17, $2.02 > 1.40, p < 0.001$) increased in February. Among the SR, we found that the proportion of loss of appetite (Q18, $1.35 < 2.05, p < 0.001$), insomnia ($1.47 < 2.05, p < 0.001$), and poor sleep quality (Q20, $1.61 < 1.62, p < 0.001$) has decreased in February by comparing the data in January and February.

3.2 Gender differences in stress responses

It can also have been found in the survey that the gender has a significant effect on stress responses, as shown in Table 4.

INSERT TABLE 4 HERE

It can be seen from the data that in addition to the somatic response (SR), the other five dimensions have significant differences regarding gender, that is, while facing the epidemic, stress reactions of females are significantly greater than males. The results are as follows: SS ($2.43 > 2.34$, $p < 0.001$), SA ($2.77 > 2.61$, $p < 0.001$), CD ($4.12 > 3.94$, $p < 0.001$), CI ($2.45 > 2.34$, $p < 0.001$), ER ($1.81 > 1.70$, $p < 0.001$), SR ($p = 0.91 > 0.05$).

4. Discussion

4.1 Analysis of the causes of different psychological stress reactions at different stages

4.1.1 Causes of differences in Traumatic Psychological Stress

In the two surveys, the differences of all six variables were significant. Except two variables of SS and ER that have risen. However, all of the other variables have reduced significantly in February compared to January. This may be explained by the fact that at the early stage of the outbreak, the participants in Hubei had not realized the severity of the epidemic and felt that the virus was far from them. In Hubei, because the epidemic prevention department did not understand the nature of the virus at the early stage, the Hubei Provincial Government thought that this new disease is not serious and it can be prevented and controlled easily, In the February survey, the stress susceptibility and emotional responses of Hubei participants were far more severe than those in January. And where do their stressors come from? We can glimpse through the previous studies. These stressors include worrying about infecting family members, feelings of uncertainty, inadequate staffing levels [24], the

virulence of the disease and inappropriate equipment [25], personal danger, and nosocomial spread.

After February, the central government sent an investigation team to Wuhan to uncover the truth so that it could be placed on the public. In the January survey, college students in Hubei were more optimistic than in February, they did not see the severity of the epidemic and felt that the virus was far away from them at the beginning [26]. The Hubei Provincial Government did not take strong measures in time [27]. The information received by people is not symmetrical with the facts, it will cause greater panic later [28], because they were in the center of the epidemic, the one near the disaster was prone to be in panic [29, 30]. Only then did the public realize that the number of confirmed cases had skyrocketed, and the participants in Hubei had only gradually realized the severity of the epidemic. The participants in the hardest-hit area of the epidemic started thinking seriously about the danger they may be facing. A large number of cases were included on February 13, and more than 10,000 diagnoses were exposed on that one day. Daily diagnostic data and the number of deaths were shocking. Especially, the media frequently reported the news of the death of front-line medical staff. The participants in the severely affected areas no longer dared to despise the epidemic and became more nervous and fearful. After the state put forward protective measures for home isolation for fourteen days, cut off transportation, banned group activities, and instituted roadblocks in urban villages. These measures created intense tension among the people living in groups. There are further stress symptoms that occur due to excessive daily browsing of the relevant news which directly affects the negative emotions of the participants. In particular, it was seen that work resumed everywhere, and the resumption of classes was just around the corner; however, the resumption of course at Hubei universities was far away, which made the participants in Hubei feel more anxious. What are worse, living resources were scarce, and medical resources and health protection still have problems in Hubei. Besides, from time to time, unreliable fake news occurs that were

disturbing participants who could not distinguish between true and false which causing a wide range of anxiety, and severely disturbing the emotions of the participants in Hubei resulting in their current high level of anxiety. Increasing numbers of newly diagnosed patients have increased the pressure on the participants in Hubei. The worst-hit area of the epidemic, and their negative emotions have become more serious. This situation can easily cause the traumatic stress responses of the participants who have intense empathy. Society should give attention to such participants and give professional psychological help.

However, two variables of risk cognition, somatic responses and stress adjustment have eased. This is because after February 4, the number of confirmed diagnoses in all regions except Hubei Province continued to decrease. By February 23, 24 provinces had 0 newly confirmed cases. In addition, the emergence of cured patients in February occurred due to injecting people with heart-strengthening agents, and the number of cured patients increased. On February 22th, more than 20,000 people were cured nation widely, which increased the people's confidence in fighting the epidemic. With the gradual release of isolation measures in other provinces across the country, the determination of work start time which was the opening of road traffic. Outside Hubei Province, people can see the hope of ending the epidemic. While gradually coming back to normal, the cognition of danger and illness gradually has been lower.

4.1.2 Causes of the different stress reactions of different genders

Regarding gender differences, it has been found that the stress reactions of female in the face of epidemics are more severe than those of male. It is physiologically explained that female hormone levels are more likely to fluctuate, and they have stronger responses to emergencies than male. Stress reactions are also more likely to produce tension, anxiety, worry, stress and other stress reactions or emotions. Previous research found that the proportion of female who have severe anxiety and other psychological stress is higher than that of male during the emergencies [31-33].

Another research has found that point prevalence of depression was significantly higher in female (14.4%) [34]. From a psychological perspective, females are generally more sensitive than males and have stronger empathy in the face of major disasters. In addition, females are more likely to accept hints than males. The emotions of the people around them and the events that occur around them will trigger females' psychological responses.

5. Clinical implications

5.1 Proper handling of negative information to reduce negative emotions

Since the outbreak, a lot of negative information about the outbreak has appeared on the Internet and even on many mobile phone software programs. We usually learn negative information about the epidemic through the Internet or our peers in China, and it is the same in other countries, for example, mass media and peer-educators were the information channel most frequently accessed in Vietnam [35]. The public in Vietnam relied on online sources, whether through official websites or phone-based applications, to acquire up-to-date health information which provides accurate instructions, and limit misinformation [36]. We know that negative information will increase stress and anxiety for people that further may affect people's physical and mental health. As part of the New Era, as a whole, participants will deal with the negative information about the epidemic more rationally.

The researcher Lyrakos [37] has found that social events and education affect negative emotions such as stress and anxiety. The outbreak area of this epidemic was in Hubei Province which is the hardest-hit area where participants experienced terrible anxiety and worry. The government and society should pay more attention to these participants and provide psychological help. We thus make the following suggestions. ① To establish a psychological counseling hotline in major communities, answer psychological counseling calls, and conduct psychological counseling for participants in the hardest-hit areas. ② To set up a psychological protection team in

each community to return to the hardest-hit participants regularly. ③ To exercise more hwo to maintain regular schedules and stabilize emotions. Long-term health problems and loss of function might play important roles in prolonging PTSD [38]. ④ When you are in a bad mood, you can use counseling, exercise, and intervention to guide you. ⑤ Follow up on the psychological conditions of the participants in the hardest-hit areas in a timely manner after the epidemic and provide the necessary post-traumatic psychological stress treatment.

5.2 Reduce stress and emotional stress through proper time management and home learning

The outbreak of COVID-19 disrupted the original life and study plans of the participants. To prevent infection, they can only isolate themselves at home and can not go out. An extended vacation was finally realized, but the participants felt that the extended vacation was not as good as imagined. Some participants indicated that they had difficulties in learning and living, and they experienced problems such as boredom and anxiety. This may be due to the participants not reasonably arranging their free time and inner emptiness. Starting in childhood, the participants' time was arranged, learning was arranged, and life was arranged. Once there was a short vacation, they would sleep, play games, etc. Suddenly, with so much free time, there is no other thing to do. We may address this issue, when participants are taught how to arrange their time independently, how to find their interests and how to develop long-term habits in their daily lives. In addition, we can use cognitive behavior therapy (CBT), especially internet CBT, which can help people to combat anxiety with the use of relaxation techniques and prevent depression onset by altering the schedule of their routine activities [39]. The time and place of treatment is limited due to the epidemic, and this is where Internet CBT emerges as a local adaptation , researchers have indicated that the Internet CBT has been proven to be useful and efficacious for both psychiatric and medical conditions [40], there are data which can provide strong support for the effectiveness of I-CBT in treating psychological and

physical adverse reactions such as insomnia [41].

Our suggestions are as follows: ① To cultivate the participants' core literacy, increase the participants' self-learning ability, and make the participants learn to arrange their study time rationally; and ② To cultivate the participants' interests or hobbies and guide the participants to continue their hobbies for a long time. ③ CBT can be conducted via the Internet or telephone for students with severe psychological stress to reshape their perceptions of themselves, things, and the epidemic, and to help them get rid of the adverse effects of negative information.

5.3 Reducing psychological stress through emotional grooming and self-adjustment

Stress is an emotional response that may be caused by emergencies. More diagnoses every day, urgent medical supply needs in major hospitals, and other negative news would increase the stress and negative emotions among participants. Furthermore, many participants in Hubei will also face discrimination, like with SARS when its associated psychiatric problems caused stigmatization [42]. In recent years, "stress" has become a term that has been mentioned increasingly. More often social competition has become increasingly more intense, and the stress of the participants has also increased. Increasingly, psychological pressures such as academic pressures, employment pressures, etc. can overwhelm a person. If they are not aware of the problem in time and do not actively solve it will cause serious consequences. Therefore, for contemporary society, it is necessary to allow people to release stress through appropriate channels.

There are many ways to self-adjust, including seeking psychological intervention and speaking and talking to relatives and friends. Although the participants improved in February in terms of their cognition and physical responses, there were still a small number of participants who made self-adjustments by finding resources for psychological intervention. Most of the participants, nearly 80%, were not willing to

look for professional psychological intervention. This reflects the lack of the mental health education in China.

We suggest the following: add mental health courses at all levels of schools and educational institutions; organize group counseling regularly; teach people how to properly treat their emotional problems, how to control themselves, and what kind of help they should seek if they cannot control their psychological problems.

6. Limitation

There are some limitations in this study, only small structured interviews were conducted at the beginning of the self-administered questionnaire, yet due to time and technical constraints, we were not able to do functional neuroimaging. This study mainly used self-reported questionnaires to measure psychiatric symptoms and did not make clinical diagnosis. **The gold standard for establishing psychiatric diagnosis involved structured clinical interview and functional neuroimaging [43, 44].** Besides, there is non participation of the foreign students in the survey as they are the hardest hit. Therefore, in the future research, more scientific and accurate methods, such as brain imaging technology, fMRI, fNIRS, etc. are needed to accurately establish psychiatric diagnosis after the epidemic in different countries. At the same time, it is necessary to adopt different psychotherapy methods for different groups and for different psychosomatic problems to provide better mental health services for people.

7. Conclusion

By investigating the stress reactions of participants at different stages after the outbreak of COVID-19, it was found that in the face of public health emergencies, participants in the hardest-hit areas were more vulnerable to stress and emotional responses during the outbreak than those in other areas. As the epidemic developed, stress adjustments, somatic responses, danger cognition, and disease cognition improved. Furthermore, it was also found that females have stronger stress reactions

than males. The government and society need to pay special attention, especially to ensure the daily lives and physical health of the people in the hardest-hit areas.

Journal Pre-proofs

Acknowledgments

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Conflicts of interest statement

All the authors have approved the manuscript and agree with its submission to your esteemed journal. There are no conflicts of interest to declare.

Journal Pre-proofs

Figure Legends

Figure 1. Fitting indexes of the model

Journal Pre-proofs

References

- [1] Wang C, PW Horby, FG Hayden, and GF Gao, A novel coronavirus outbreak of global health concern. *The Lancet* 2020; 395(10223).
- [2] Huang C *et al.*, Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *The Lancet* 2020; 395(10223): 497-506.
- [3] Lupia T, S Scabini, SM Pinna, GD Perri, FGD Rosa, and S Corcione, 2019 novel coronavirus (2019-nCoV) outbreak: A new challenge. *Journal of Global Antimicrobial Resistance* 2020; 21.
- [4] Wilson ME and LH Chen, Travelers Give Wings to Novel Coronavirus (2019-nCoV). *Journal of travel medicine* 2020.
- [5] Xiong J *et al.*, Impact of COVID-19 pandemic on mental health in the general population: A systematic review %J *Journal of Affective Disorders*. 2020; 277.
- [6] Cuiyan W *et al.*, Immediate Psychological Responses and Associated Factors during the Initial Stage of the 2019 Coronavirus Disease (COVID-19) Epidemic among the General Population in China. %J *International journal of environmental research and public health*. 2020; 17(5).
- [7] Wang C *et al.*, A longitudinal study on the mental health of general population during the COVID-19 epidemic in China %J *Brain Behavior and Immunity*. 2020; 87.
- [8] Pan X, DM Ojcius, T Gao, Z Li, C Pan, and C Pan, Lessons learned from the 2019-nCoV epidemic on prevention of future infectious diseases. *Microbes and Infection* 2020.
- [9] Khan BT, Coronavirus in China. *The Lancet. Respiratory medicine* 2020.
- [10] Jang M, S-h Lee, and L-j Kim, Post-traumatic stress disorder and behavioral problems of parents and children after the 2015 Nepal earthquakes. *International Journal of Mental Health* 2020; 49(1): 3-16.
- [11] Tan W *et al.*, Is returning to work during the COVID-19 pandemic stressful? A study on immediate mental health status and psychoneuroimmunity prevention measures of Chinese workforce %J *Brain Behavior and Immunity*. 2020; 87.
- [12] Hao F *et al.*, Do psychiatric patients experience more psychiatric symptoms during COVID-19 pandemic and lockdown? A case-control study with service and research implications for immunopsychiatry %J *Brain Behavior and Immunity*. 2020; 87.
- [13] Lisa HT, GM R, DJ L, Q Kimberly, and DA L, Morphine use after combat injury in Iraq and post-traumatic stress disorder. *The New England journal of medicine* 2010; 362(2).
- [14] Thanh LXT *et al.*, Evaluating the Psychological Impacts Related to COVID-19 of Vietnamese People Under the First Nationwide Partial Lockdown in Vietnam %J *Frontiers in Psychiatry*. 2020.
- [15] Tee ML *et al.*, Psychological impact of COVID-19 pandemic in the Philippines %J *Journal of Affective Disorders*. 2020; 277.
- [16] Sattler DN, S Assanangkornchai, AM Moller, W Kesavatana-Dohrs, and JM Graham, Indian Ocean tsunami: relationships among posttraumatic stress, posttraumatic growth, resource loss, and coping at 3 and 15 months. *Journal of trauma & dissociation: the official journal of the International Society for the Study of Dissociation (ISSD)* 2014; 15(2): 219-239.
- [17] Kjaer FA, M Hanspeter, and S Ulrich, Does acute stress disorder predict post-traumatic stress

- disorder in traffic accident victims? Analysis of a self-report inventory. *Nordic journal of psychiatry* 2004; 58(3).
- [18] Obergriesser S and H Stoeger, Students' emotions of enjoyment and boredom and their use of cognitive learning strategies – How do they affect one another? *Learning and Instruction* 2020; 66.
- [19] Li S *et al.*, Psychological typhoon eye in the 2008 Wenchuan earthquake. *PLoS ONE* 2017; 4(3).
- [20] Li J, Instructional Research on Mental Health Education for College Students from the Perspective of Positive Psychology. *Psychology* 2020; 11(01): 49-53.
- [21] Dale H, L Watson, P Adair, and G Humphris, Assessment of an innovative behaviour change intervention for looked after young people through applying Health Psychology and Public Health. *The Lancet* 2012; 380: S33.
- [22] Zhang Y *et al.*, Emotional “inflection point” in public health emergencies with the 2019 new coronavirus pneumonia (NCP) in China %J *Journal of Affective Disorders*. 2020; 276.
- [23] Guixiang W *et al.*, Psychological Typhoon Eye Effect During the COVID-19 Outbreak %J *Frontiers in Public Health*. 2020.
- [24] Taylor S, B White, and S Muncer, Nurses' cognitive structural models of work-based stress. *Journal of Advanced Nursing* 1999; 29(4).
- [25] Carolyn F and B Karen, Responding to the severe acute respiratory syndrome (SARS) outbreak: lessons learned in a Toronto emergency department. *Journal of emergency nursing: JEN : official publication of the Emergency Department Nurses Association* 2003; 29(3).
- [26] Zheng R *et al.*, The more involved in lead-zinc mining risk the less frightened: A psychological typhoon eye perspective. *Journal of Environmental Psychology* 2015; 44.
- [27] Zhu N *et al.*, A Novel Coronavirus from Patients with Pneumonia in China, 2019. *N Engl J Med* 2020; 382(8): 727-733.
- [28] Forsell E *et al.*, Development of a very brief scale for detecting and measuring panic disorder using two items from the Panic Disorder Severity Scale-Self Report. *Journal of Affective Disorders* 2019; 257: 615-622.
- [29] Derrick K, T Green, and T Wand, Assessing and responding to anxiety and panic in the Emergency Department. *Australasian Emergency Care* 2019; 22(4): 216-220.
- [30] Johnson AL, AC McLeish, PK Shear, and M Privitera, Panic and epilepsy in adults: A systematic review. *Epilepsy & Behavior* 2018; 85: 115-119.
- [31] Zhang M, J Zhang, F Zhang, L Zhang, and D Feng, Prevalence of psychological distress and the effects of resilience and perceived social support among Chinese college students: Does gender make a difference? *Psychiatry Research* 2018; 267: 409-413.
- [32] Liu H, Y Wu, D Lei, and B Li, Gender differences in physiological and psychological responses to the thermal environment with varying clothing ensembles. *Building and Environment* 2018; 141: 45-54.
- [33] Olaseni AO, OS Akinsola, SF Agberotimi, and R Oguntayo, Psychological distress experiences of Nigerians during Covid-19 pandemic; the gender difference. *Social Sciences & Humanities Open* 2020; 2(1): 100052.
- [34] Y LG, TW W, L Yanxia, HC S, ZM W, and HR C, Prevalence of Depression in the Community from 30 Countries between 1994 and 2014. %J *Scientific reports*. 2018; 8(1).

- [35] Xuan TB *et al.*, Coverage of Health Information by Different Sources in Communities: Implication for COVID-19 Epidemic Response. %J International journal of environmental research and public health. 2020; 17(10).
- [36] Thi LH *et al.*, Demand for Health Information on COVID-19 among Vietnamese. %J International journal of environmental research and public health. 2020; 17(12).
- [37] Lyrakos G, M Ypofandi, A Chasapis, E Aslani, and V Spinaris, EPA-1595 - Factors affecting negative emotions of depression, anxiety and stress in online social networking services. European Psychiatry 2014; 29.
- [38] J CV, LT J, WR A, KJ A, HP L, and CG L, Psychosocial sequelae of the 1989 Newcastle earthquake: II. Exposure and morbidity profiles during the first 2 years post-disaster. Psychological Medicine 1997; 27(1).
- [39] Sh HC, CC Yi, and HR Cm, Mental Health Strategies to Combat the Psychological Impact of COVID-19 Beyond Paranoia and Panic. %J Annals of the Academy of Medicine, Singapore. 2020; 49(3).
- [40] B ZMW and HRC M, Moodle: The cost effective solution for internet cognitive behavioral therapy (I-CBT) interventions. %J Technology and health care : official journal of the European Society for Engineering and Medicine. 2017; 25(1).
- [41] Soh HL, RC Ho, CS Ho, and WW Tam, Efficacy of digital cognitive behavioural therapy for insomnia: a meta-analysis of randomised controlled trials %J Sleep Medicine. 2020; 75.
- [42] Lee S, LYY Chan, AMY Chau, KPS Kwok, and A Kleinman, The experience of SARS-related stigma at Amoy Gardens. Social Science & Medicine 2005; 61(9).
- [43] Fabeha HS *et al.*, Validating a functional near-infrared spectroscopy diagnostic paradigm for Major Depressive Disorder. %J Scientific reports. 2020; 10(1).
- [44] H HCS *et al.*, Diagnostic and Predictive Applications of Functional Near-Infrared Spectroscopy for Major Depressive Disorder: A Systematic Review. %J Frontiers in psychiatry. 2020; 11.

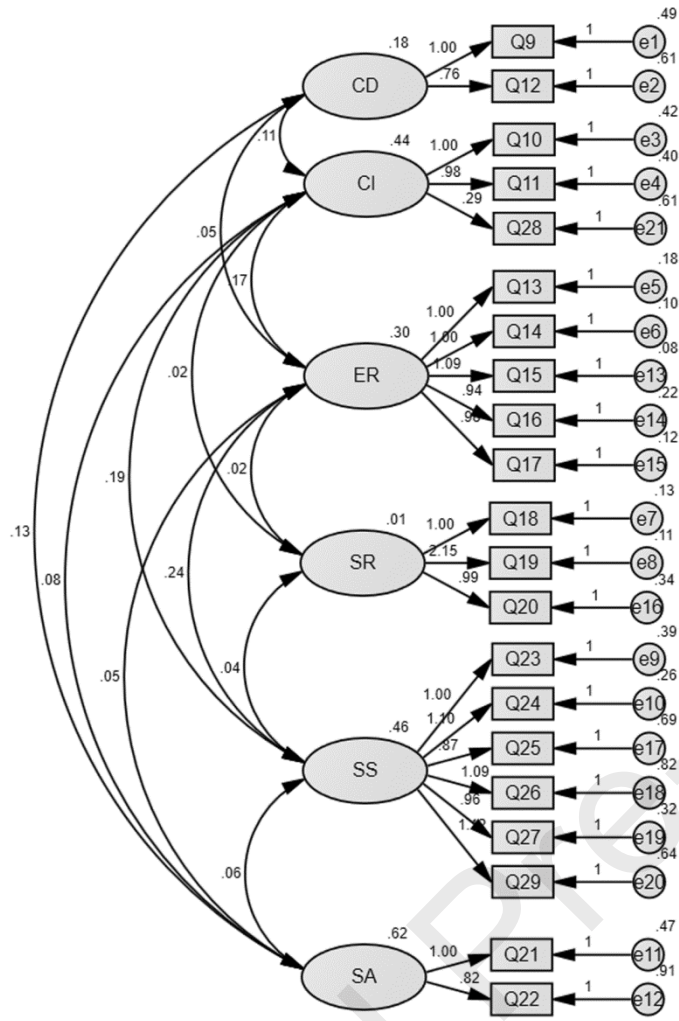


Table 1. Items loadings, eigenvalues, and variance of the Stress Response with PCA.

Factor	Item	Number	Loading	Eigenvalue	% of variance
Cognition of danger	The severity of the epidemic	Q9	0.77	1.11	6.71
	Necessary of isolation	Q12	0.80		
Cognition of illness	Own risk	Q10	0.65	1.77	8.03
	Probability of catching the COVID-19	Q11	0.71		
	COVID-19 can be cured	Q28	0.66		
Emotional responses	More nervous	Q13	0.81	6.00	19.04
	Afraid for no reason	Q14	0.80		
	Easily upset or frightened	Q15	0.88		
	Feel depressed	Q16	0.82		
	More anxious	Q17	0.82		
Somatic reactions	Losing appetite	Q18	0.78	1.21	6.89
	Sleep less	Q19	0.72		

	Sleep worse	Q20	0.45		
Stress susceptibility	Easily angry	Q23	0.70	2.01	15.97
	More moody	Q24	0.82		
	Afraid of catching COVID-19	Q25	0.73		
	Troubled with COVID-19	Q26	0.57		
	Hard to focus on things except COVID-19	Q27	0.82		
	Full of stress	Q29	0.60		
Stress adjustment	Need psychological counseling	Q21	0.86	1.47	7.93
	Need talking to families	Q22	0.80		

Table 2. Correlation test of items in the questionnaire (n=363)

Items	CD	CI	ER	SR	SS	SA
CD	1.00					
CI	0.14**	1.00				
ER	0.00	0.38**	1.00			
SR	-0.04	0.00	0.06	1.00		
SS	0.03	0.22**	0.55**	0.16**	1.00	
SA	0.08	0.04	0.02	-0.05	0.18**	1.00

Note ** $p < 0.01$ (two-tailed test)

CD: cognition of danger, CI: cognition of illness, ER: emotional responses, SR: somatic reactions, SS: stress susceptibility, SA: stress adjustment

Table 3 T-test of six variances on January and February

	Time	Mean±SD	t	p
SS	January	2.33±0.75	-11.91	<0.001
	February	2.45±0.66		
SA	January	3.34±0.90	95.75	<0.001
	February	2.08±0.84		
CD	January	4.30±0.63	46.8	<0.001
	February	3.78±0.82		
CI	January	2.52±0.61	23.52	<0.001
	February	2.29±0.66		
ER	January	1.48±0.56	-58.5	<0.001
	February	2.03±0.69		
SR	January	1.91±0.32	63.41	<0.001
	February	1.48±0.54		

Note SS: stress susceptibility, SA: stress adjustment, CD: cognition of danger, CI: cognition of illness, ER: emotional responses, SR: somatic reactions

Table 4. T-test of 6 dimensions based on sex

	Sex	Mean±SD	t	p
SS	Male	2.34±0.74	-7.53	< 0.001
	Female	2.43±0.68		
SA	Male	2.61±1.10	-9.41	< 0.001
	Female	2.77±1.05		
CD	Male	3.94±0.85	-14.96	< 0.001
	Female	4.12±0.71		
CI	Male	2.34±0.68	-10.81	< 0.001
	Female	2.45±0.62		
ER	Male	1.70±0.70	-10.07	< 0.001
	Female	1.81±0.68		
SR	Male	1.69±0.49	-5.95	0.91
	Female	1.69±0.50		

Note SS: stress susceptibility, SA: stress adjustment, CD: cognition of danger, CI: cognition of illness, ER: emotional responses, SR: somatic reactions

Author Statement

The study was designed in accordance with the tenets of the Declaration of Helsinki. Approval from the ethical authority of School of Educational Science, Huazhong University of Science and Technology was granted. Confidentiality and the statement confirming informed consent was managed by placing anonymous coding of one self-report questionnaires.

This manuscript has not been published or presented elsewhere. All study participants provided informed consent, and the study design was approved by the appropriate ethics review boards. All the authors have approved the manuscript and agree with submission to your esteemed journal. There are no conflicts of interest to declare.

Conceived and designed the questionnaire: ZY, XYF. Recruitment and payment of participants: ZY, LGH, ZJY, XQ. Analyzed the data: CXC, ZQY, WGX, BYR, XSM, HF. Wrote and revised the paper: CXC, KA.

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