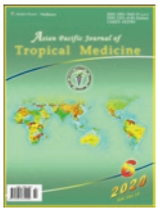

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Psychological impacts of the COVID–19 epidemic on Chinese people: Exposure, post–traumatic stress symptom, and emotion regulation

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ABSTRACT

Objective: To examine the effects of coronavirus disease-2019 (COVID-19) exposure, expressive suppression/cognitive reappraisal, and demographic variables on post-traumatic stress symptoms (PTS) among Chinese.

Methods: Participants were recruited by social media through WeChat and 6 049 Chinese (aged from 17 to 63 years; median=24) from 31 provinces were included in the study. PTS symptoms, expressive suppression, and cognitive reappraisal were assessed after the outbreak of COVID-19. A regression mixture analysis was conducted in Mplus 7.

Results: A regression mixture model identified three latent classes that were primarily distinguished by differential effects of COVID-19 exposures on PTS symptoms: (1) Class 1 (mildly PTS symptoms, 80.9%), (2) Class 2 (moderate PTS symptoms, 13.0%), and (3) Class 3 (high PTS symptoms, 6.1%). The results demonstrated that the young, women and people with responsibilities and concerns for others were more vulnerable to PTS symptoms; and they had more expression inhibition and less cognitive reappraisal in three latent classes.

Conclusions: The findings suggest that more attention needs to be paid to vulnerable groups such as the young, women and people with responsibilities and concerns for others. Therapies to encourage emotional expression and increase cognitive reappraisal may also be helpful for trauma survivors.

KEYWORDS: COVID-19 exposures; Post-traumatic stress symptoms; Expressive suppression; Cognitive reappraisal

1. Introduction

The coronavirus disease-2019 (COVID-19) is a rapidly emerging infectious disease. Early stages of the disease include severe acute respiratory infection, with some patients rapidly developing acute respiratory distress syndrome (ARDS), acute respiratory failure, and other serious complications[1]. COVID-19 is highly infectious, spreading quickly worldwide, and asymptomatic individuals have been identified as potential sources of infection[2]. The number of identified COVID-19 cases has been steadily growing, and till March 22, 2020, a total of 292 142 cases has been reported globally[3]. Along with severe health problems, the disease has imposed a great psychological impact on the public. The widespread media attention concerning the severity of the epidemic has acutely alarmed the public.

The level and type of psychological impact on individuals during an epidemic can vary greatly depending on the degree of experienced exposure. Previously, Shi and colleagues investigated the psychological impact of the SARS virus by surveying a stratified sample of 4 231 people from 17 cities in China[4]. The study found a decrease in personal interest, an increase in the level of risk perception, and irrational anxiety and fear. Due to a high exposure level, healthcare workers and patients with SARS reported the greatest emotional distress[5,6]. In addition, the SARS outbreak caused post-traumatic stress (PTS) symptomatology resembling those caused by other extreme stress situations such as terrorist attacks or earthquakes[6–9]. A large proportion of community

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respondents in a study in Hong Kong reported experiencing moderate to severe PTS symptoms from June 2003 to January 2004 after the SARS outbreak[10]. Another study found that 44.1% (n=68) of patients diagnosed with SARS developed post-traumatic stress disorder (PTSD) over a 2-46 months period following discharge from hospitalization[8]. Moreover, approximately 10% of hospital employees in Beijing experienced high levels of PTS within three years of the SARS outbreak[6]. However, to the best of our knowledge, no prior studies have systematically assessed PTS symptoms in individuals with varied exposure levels in the Chinese mainland.

Retrospective studies suggest a link between PTS symptoms and emotion regulation issues[5,11]. Emotion regulation, based on Gross[12], is "the processes by which individuals influence which emotions they have, when they have them, and how they experience or express these emotions". According to this model, expressive suppression and cognitive reappraisal are the most common emotion regulation strategies. Expressive suppression, which refers to the inhibition of external cues (such as facial expression) related to one's internal emotional state, has been associated with PTS symptoms and chronic PTSD[13,14]. Cognitive reappraisal, which involves reframing emotion-eliciting experiences or stimuli in order to dampen their impact, has been associated with a decrease in self-reported PTS symptoms[11]. However, these prior studies did not take the degree of trauma exposure into consideration when examining the relationship between expressive inhibition/cognitive reappraisal and PTS symptoms.

To address gaps in the existing literature, the current study examined the level of PTS symptomatology among Chinese people experiencing varying COVID-19 event exposure and investigated latent subgroups of participants. Additionally, the relationship between PTS symptoms and expressive suppression/cognitive reappraisal by the degree of COVID-19 exposure was analyzed. Lastly, differences in demographic variables among the latent subgroups were examined. Improving the understanding of the psychological impact of exposure to an outbreak of a fast-spreading, life-threatening infectious disease will strengthen response preparations for future outbreaks or pandemics.

2. Subjects and methods

2.1. Participant recruitment and sample demographics

The data collection started on 28 January 2020 when Hainan Province announced the psychological assistance hotline to help prevent and control COVID-19. Participants were recruited by social media through WeChat. Respondents were firstly asked to read an informed consent and would enter the survey only if they agreed. A total of 6 172 Chinese participants were collected. After screening, 6 049 (98.01%) were included in the study and they were from 31 provinces, autonomous regions, and municipalities.

Participants were 25.19% male (n=1 524) and 74.81% female (n=4 525), ranging in age from 17 to 63 years (Median=24). Participant occupations include students (64.90%, 3 926) followed by medical workers (29.00%, n=1 754), office workers (3.44%, n=208), teachers (1.95%, n=118), freelancers (0.36%, n=22) and unemployed (0.35%, n=21). In terms of marital status, 22.10% (n=1 337) were married; 0.50% (n=30) were divorced, 77.30% (n=4 676) were never married, and 0.10% (n=6) were widowed. Of the 6 049 participants, 0.10% (n=6) were of elementary school or lower degree, 0.30% (n=18) had completed junior high school, 1.12% (n=68) were of senior high school degree, 5.06% (n=306) had completed vocational high school, the majority of the sample (90.01%, n=5 445) had obtained a undergraduate degree, 3.41% (n=206) had got postgraduate degree. Based on the guiding principles of emergent psychological crisis intervention in COVID-19[15], populations affected by COVID-19 were divided into 4 levels: Patients with severe symptoms of COVID-19, front-line medical workers, CDC researchers or administrative staff are in Level 1; patients with mild symptoms of COVID-19, close contacts, suspected patients, or patients with fever who come to the hospital for treatment are in Level 2; people related to the first and second-level population, such as family members, colleagues or friends, rescuers, such as commanders, administrative staff, or volunteers are in Level 3; people in affected areas, susceptible groups, or the general public are in Level 4. In this study, the level of the exposure to COVID-19 was as follows: 14.20% (n=859) in the first level, 0.45% (n=27) in the second level, 6.23% (n=377) in the third level, 79.12% (n=4 786) in the fourth level. The sociodemographic characteristics of the sample are listed in Table 1.

2.2. Measurements

2.2.1. PTS symptoms

The PTSD checklist for DSM-5(PCL-5) was used to measure PTS symptoms[16,17]. Each item of the 20-item self-report scale is scored 0 (not at all) to 4 (very seriously). Therefore, total-symptom scores can range from 0 to 80. Reliability statistics for the PCL-5 indicate a good internal consistency for the total score (α=0.91) and all subscale scores (intrusion α=0.83; avoidance α=0.85; negative alterations in cognition/mood α=0.91; and arousal α=0.90).

2.2.2. Expressive suppression and cognitive reappraisal

The Chinese version of the Emotion Regulation Questionnaire (ERQ) consists of 10 items that measure two factors: expressive suppression (4 items) and cognitive reappraisal (6 items)[18]. Each item of the ERQ is scored 1 (completely disagree) to 7 (completely agree). The Chinese version of the ERQ shows good validation in Chinese individuals with a Cronbach's α of 0.81 and 0.91 for expressive suppression and cognitive reappraisal, respectively.

2.3. Statistical analyses

Data were analyzed using SPSS 21 (IBM Corp., Armonk, NY). A regression mixture analysis was conducted in Mplus 7 (Muthén &

Table 1. Comparison of PTS scores among different demographic characteristics.

Variables	*n*	PTS score (Mean±SD)	*F* or *t*	*P*	*Post-hoc* pairwise comparisons (*P*<0.05)
COVID-19 exposure			142.065	<0.001	a>c; a>d; b>d; c>d
a.First	859	1.51±0.15			
b.Second	27	1.48±0.15			
c.Third	377	1.48±0.15			
d.Fourth	4 786	1.42±0.12			
Gender			-7.104$^{\#}$	<0.001	
Male	1 524	1.41±0.19			
Female	4 525	1.44±0.13			
Level of education			11.708	<0.001	a>c; b>c; b>e; b>f; c<d; c<e; c<f; d>e; d>f
a.Elementary school or less degree	6	1.53±0.21			
b.Junior high school degree	18	1.51±0.16			
c.Senior high school degree	68	1.39±0.10			
d.Vocational high school degree	306	1.48±0.15			
e.Undergraduate degree	5 445	1.43±0.13			
f.Postgraduate degree	206	1.44±0.11			
Marital status			119.553	<0.001	a<b; a<c; b>d; c>d
a.Never married	4 676	1.41±0.12			
b.Married	1 337	1.50±0.15			
c.Divorced	30	1.50±0.16			
d.Widowed	6	1.44±0.21			
Occupation			151.408	<0.001	a<b; a<d; a<f; b>c; b>d; c<f; d<f
a.Students	3 926	1.40±0.11			
b.Medical workers	1 754	1.50±0.15			
c.Office workers	208	1.41±0.11			
d.Teachers	118	1.44±0.11			
e.Freelancers	22	1.45±0.16			
f.Unemployed	21	1.43±0.13			
Whether you have children			17.907$^{\#}$	<0.001	
Yes	1 216	1.50±0.15			
No	4 833	1.42±0.12			
Residence status			8.704$^{\#}$	<0.001	
Living alone	648	1.48±0.15			
Living with family/friends/classmates/ colleagues	5 401	1.43±0.13			
Whether your family or friends are healthcare workers			11.409$^{\#}$	<0.001	
Yes	2 625	1.46±0.14			
No	3 424	1.42±0.12			
Whether your family or friends are infected with COVID-19			27.294	<0.001	a<b; b>c; b>d; c<d
a.Someone diagnosed	7	1.42±0.07			
b.Someone suspected	13	1.65±0.19			
c.No infection	5 876	1.43±0.13			
d.Unclear	153	1.51±0.16			
Number of siblings			57.860	<0.001	a< b <c <d <e
a.Zero	1 023	1.40±0.11			
b.One	1 685	1.42±0.12			
c.Two	1 558	1.44±0.13			
d.Three	1 007	1.45±0.14			
e.Four or more	776	1.48±0.14			
Seniority among brothers and sisters			27.456	<0.001	a<b<c<d
a.First	3 365	1.42±0.13			
b.Second	1 582	1.44±0.13			
c.Third	648	1.45±0.13			
d.Fourth or less	454	1.48±0.14			
Whether your family or friends have been to Wuhan recently			2.050$^{\#}$	0.040	
Yes	79	1.46±0.15			
No	5 970	1.43±0.13			

Note: PTS=post traumatic stress. The PTS original data did not conform to the normal distribution but did after logarithmic transformation, and then the *F* or *t*-test was adopted. With $^{\#}$: *t*-test; Without $^{\#}$: *F* test.

Muthén, Los Angeles, CA). The significance threshold was set at 0.05.

The mean values and standard deviation of each variable were calculated for the evaluation of the homogeneity of variance and the normality of distribution of measured data. The PTS original data did not conform to the normal distribution but did after a logarithmic transformation, and then one way analysis of variance (One way ANOVA) with *post hoc* comparisons(Scheffé method) was performed to compare three or more groups and *t* test was used to compare two groups[19].

Spearman's rho was used to analyze the correlation between PTS, expressive suppression, and cognitive reappraisal. Kendall's tau coefficient was used to analyze the correlation between COVID-19 exposure and PTS, expressive suppression, a cognitive reappraisal.

A regression mixture model was used to identify the optimal number of participant subgroups. The relationships between independent variables (COVID-19 exposure, expressive suppression, and cognitive reappraisal) and the dependent variable (PTS) varied between subgroups. A regression mixture model combines the advantages of a regression model with a person-centered analysis to identify the differential relationships between independent variables and dependent variables in subgroups[20,21]. In the current study, models with one to four latent subgroups were tested. Differences in residual variances for PTS scores were allowed between subgroups. Outcome means and regression weights of PTS scores with each independent factor (exposure to COVID-19, expressive suppression, and cognitive reappraisal) were also permitted to differ between subgroups. To reduce the effect due to local maxima[22,23], the number of random sets of starting values was increased to 1 000, the number of iterations was set at 20, and the number of final-stage optimizations was set at 100[24].

Multiple fit indices were used to determine the best fitting model. Specifically, the Akaike information criterion, Bayesian information criterion (BIC), and adjusted BIC were measured. The best model was chosen by determining which model had the lowest values across each criterion. In latent profile analysis, the entropy is computed to identify the latent classes as a useful measurement instrument, with values exceeding 0.80 and ideally approaching 1.0 demonstrating much clearer results[25]. In addition, the high value of entropy is the basis for multinomial logistic regression[20,26]. The Lo-Mendell-Rubin and bootstrapped likelihood ratio test (BLRT) were used to compare the estimated model and a model with k-1 subgroups, with k set at the number of subgroups[27]. A low and significant *P*-value resulting from the Lo-Mendell-Rubin and BLRT signified that the estimated model was superior to a model with one less subgroup[27]. In addition, to fit statistics, subgroup-specific intercepts, residual variances, and regression coefficients were examined to interpret each subgroup[20].

Multinomial regression was used to examine the moderating effects of age, gender, level of education, children, residence status, having family or friends as healthcare workers, having family or friends infected with COVID-19, number of siblings, birth order among siblings, and having family or friends visit Wuhan recently.

2.4. Ethical approval

Ethical approval for all study procedures was obtained from the Hainan Medical University Ethics Committee (No. HYLL2020006).

3. Results

3.1. Descriptive analyses

Descriptive variables were assessed directly with psychometric instruments (Table 1). Participants with greater exposure to COVID-19 scored higher on PTS symptomatology (F=142.065, P<0.001). Divorced participants scored higher on PTS symptomatology than subjects reporting other marital statuses (F=119.553, P<0.001). Unemployed participants had the highest PTS score, followed by medical workers, who were scored higher than participants working in other fields (F=151.408, P<0.001). Subjects with a family member or friend suspected with COVID-19 scored higher on PTS symptomatology than those with a family member or friend diagnosed, no infection, or unclear (F=27.294, P<0.001). In addition, higher PTS scores were more likely to be found in older, female, and people who have a higher level of education, or have children, or live alone, or have healthcare workers as family or friends, or have more siblings and are younger themselves among their sibling, or have been to Wuhan recently (all P values <0.05).

The correlation between COVID-19 exposure, PTS, expressive suppression, and cognitive reappraisal are listed in Table 2. Expressive suppression correlated with cognitive reappraisal. Both of them correlated with COVID-19 exposure and PTS. Also, the exposure to COVID-19 correlated with PTS.

Table 2. Correlations among study variables.

Variables	COVID-19 exposure	Expressive suppression	Cognitive reappraisal
PTS	-0.208***	0.221***	0.047***
COVID-19 exposure		-0.078***	-0.054***
Expressive suppression	1	1	0.497***
Cognitive reappraisal			1

Note: PTS=post-traumatic stress; Spearman's rho was used to analyze the correlation between PTS, expressive suppression, and cognitive reappraisal. Kendall's tau coefficient was used to analyze the correlation between COVID-19 exposure and PTS, expressive suppression, cognitive reappraisal. $^{***}P$<0.001.

3.2. Mixture regression: subgroup-specific associations

The multivariate non-normality test showed that testing for both multivariate skewness (sample value=22.539, mean=0.056, standard deviation=0.011, P<0.001) and kurtosis (sample value=106.702, mean=47.998, standard deviation=0.238, P<0.001) were statistically significant, indicating violation of multivariate normality assumption. The maximum likelihood estimation with robust standard errors was used to deal with non-normal data.

The main research question examined subgroups of participants based on how the level of COVID-19 exposure, expressive suppression, and cognitive reappraisal were differentially related to PTS scores. Table 3 shows the fit indices of each regression mixture solution with one to four subgroups. As hypothesized, the results indicate evidence for a moderating factor. Specifically, multiple fit indices (*i.e.*, maxima, BIC, adjusted BIC, and BLRT) suggested that a three-subgroup solution was optimal. Furthermore, the three-subgroup solution demonstrated a high degree of separation between groups with entropy at 0.978 and the lowest subgroup-specific response probability was 0.980.

Subgroups were interpreted based on specific intercepts of the outcome variables, residual variances, and regression coefficients. Parameter estimates for the three-subgroup model are provided in Tables 3, 4 and 5. According to the subscales and total scale score of PTS symptomatology, we named the three subgroups as follows: Subgroup 1 (mildly PTS symptoms), Subgroup 2 (moderate PTS symptoms) and Subgroup 3 (high PTS symptoms).

The largest portion of the sample (approximately 80.9%, n=4 891) fell into Subgroup 1 and was characterized by the lowest intercept on PTS symptom score (25). These data suggest that the participants in Subgroup 1 had relatively good adaptive adjustment within the context of a severe outbreak environment. Within Subgroup 1, the PTS was predicted by the COVID-19 exposure level (B=- 0.079, P<0.001). In addition, Subgroup 1 was the only subgroup characterized by a relationship between exposure to COVID-19 and PTS. The expressive suppression predicted PTS positively (B=0.030, P<0.001), while the cognitive reappraisal predicted PTS negatively (B=-0.006, P=0.002). Consequently, exposure to COVID-19, expressive suppression and cognitive reappraisal accounted for the lowest proportion of variance in participant PTS symptomatology (R^2=0.026, P<0.001).

Subgroup 2 (moderate PTS symptoms) comprised approximately 13.0% (n=787) of the study samples, with an intercept of 36, indicating a mildly negative response to the outbreak. Within Subgroup 2, COVID-19 exposure did not predict PTS symptomatology. There was a positive relationship between expressive suppression and PTS symptomatology (B=0.070, P<0.001) and a negative correlation between cognitive reappraisal and PTS symptomatology (B=-0.054, P<0.001). Taken together, the two emotion regulation variables accounted for only 9% of variance in the PTS symptoms among participants in Subgroup 2 (R^2=0.092, P<0.001).

Approximately 6.1% (n=371) of participants fell into Subgroup 3 (high PTS symptoms). This subgroup had the highest intercept (58) on PTS, indicating high-level maladjustment. The severity of COVID-19 exposure did not predict the PTS score. Subgroup 3 was characterized by the strongest relationships between expressive suppression and PTS scores (B=0.424, P<0.001) and between cognitive reappraisal and PTS scores (B=-0.187, P<0.001). Notably, the two variables accounted for a large amount of variance in the PTS score (R^2=0.607, P<0.001).

Due to the high entropy of the three-subgroup model, it was reasonable to continue with multinomial logistic regression analysis. The analysis tested the moderating effects of age, gender, level of education, children, residence status, having family or friends as healthcare workers, having family or friends infected with COVID-19, number of siblings, birth order among siblings, and having family or friends visiting Wuhan recently. The entropy remained stable and the subgroup-specific regression weights did not change after covariates were added, suggesting that the model was robust. The results of the regression analysis are presented in Table 5. Ten covariates were significantly related to subgroup membership. Specifically, participants with a lower level of education, with family or friends infected with COVID-19, and those having siblings were more likely to be in Subgroup 2 (moderate PTS symptoms) or Subgroup 3 (high PTS symptoms) compared to Subgroup 1 (mildly PTS symptoms). Female participants living alone were more likely to belong to Subgroup 2 (moderate PTS symptoms) than to Subgroup 1 (mildly PTS symptoms). In addition, participants who are younger, who had children, who have family or friends who are healthcare workers, who are an elder sibling and who have family or friends recently visiting Wuhan were more likely to belong to Subgroup 3 (high PTS symptoms) than Subgroup 1 (mildly PTS symptoms).

Table 3. Fit indices for the regression mixture models.

Model	No. of free para-meters	Log-likelihood	AIC	BIC	Adjusted BIC	Entropy	BLMR *P*-value	BLRT *P*-value	Class proportions
1	15	-51 883.365	103 796.729	103 897.344	103 849.678	N.A.	N.A.	N.A.	1
2	27	-49 585.554	99 225.109	99 406.215	99 320.417	0.968	0.000	0.000	0.907/0.093
3	**39**	**–48 176.240**	**96 430.479**	**96 692.078**	**96 568.147**	**0.978**	**0.005**	**0.005**	**0.809/0.130/0.061**
4	51	-47 357.281	94 816.562	95 158.652	94 996.588	0.979	0.240	0.240	0.809/0.126/0.043/0.022

Note: Final solutions are in bold. AIC=Akaike information criterion; BIC=Bayesian information criterion; BLMR=Lo-Mendell-Rubin; BLRT=bootstrap likelihood ratio test.

Table 4. Parameter estimates for the three-class model.

Variable	Subgroup 1 (mildly PTS symptoms)			Subgroup 2 (moderate PTS symptoms)			Subgroup 3 (high PTS symptoms)		
	B	*SE*	*P*	*B*	*SE*	*P*	*B*	*SE*	*P*
COVID-19 exposure	**–0.079**	**0.015**	**<0.001**	-0.059	0.038	0.127	-0.080	0.131	0.542
Expressive suppression	**0.030**	**0.003**	**<0.001**	**0.070**	**0.014**	**<0.001**	**0.424**	**0.067**	**<0.001**
Cognitive reappraisal	**–0.006**	**0.002**	**0.002**	**–0.054**	**0.009**	**<0.001**	**–0.187**	**0.034**	**<0.001**

Note: Bold font indicates statistical significance; PTS=post-traumatic stress.

Table 5. Multinomial logistic regression coefficients for demographic variables on subgroup membership.

Variable	Subgroup 2 *vs.* Subgroup 1			Subgroup 3 *vs.* Subgroup 1			Subgroup 3 *vs.* Subgroup 2		
	B	*SE*	*P*	*B*	*SE*	*P*	*B*	*SE*	*P*
Age	-0.015	0.009	0.107	**–0.056**	**0.013**	**<0.001**	**–0.040**	**0.014**	**0.005**
Gender	**0.238**	**0.107**	**0.026**	-0.172	0.142	0.224	**–0.411**	**0.168**	**0.014**
Education level	**–0.365**	**0.084**	**<0.001**	**–0.352**	**0.098**	**<0.001**	0.013	0.106	0.902
Have children	-0.291	0.201	0.148	**–0.762**	**0.241**	**0.002**	-0.471	0.264	0.075
Residence status	**–0.259**	**0.129**	**0.045**	-0.072	0.193	0.710	0.187	0.216	0.385
Have family or friends who are healthcare workers	-0.160	0.086	0.065	**–0.289**	**0.119**	**0.015**	-0.130	0.139	0.352
Have family or friends infected with COVID-19	**0.474**	**0.207**	**0.022**	**0.879**	**0.273**	**0.001**	0.405	0.313	0.196
Number of siblings	**0.178**	**0.036**	**<0.001**	**0.296**	**0.049**	**<0.001**	**0.118**	**0.054**	**0.029**
Birth order	-0.012	0.045	0.783	**–0.175**	**0.064**	**0.007**	**–0.162**	**0.072**	**0.024**
Have family or friends who have recently visited Wuhan	0.489	0.434	0.260	**–0.863**	**0.324**	**0.008**	**–1.352**	**0.485**	**0.005**

Note: Bold font indicates statistical significance.

4. Discussion

Increasingly, exposure to COVID-19 is recognized as a cause of trauma. Using the regression mixture model approach, results from the current study provide empirical support for differential effects of COVID-19 exposure severity and emotion regulation on PTS symptoms. The present study identified three distinct subgroups (Subgroup 1: mildly PTS symptoms; Subgroup 2: moderate PTS symptoms; and Subgroup 3: high PTS symptoms) that differ in PTS symptoms including re-experiencing, avoidance, negative alterations in cognition and mood, and increased arousal and reactivity; and in the relationships between PTS symptomatology and severity of COVID-19 exposure, expressive suppression and cognitive reappraisal. The mildly PTS symptoms subgroup (Subgroup 1; 80.9%) included participants whose PTS symptomatology was significantly related to COVID-19 exposure, expressive inhibition, and cognitive reappraisal. The participants included in the moderate PTS symptoms group (Subgroup 2; 13.0%) showed no significant correlation between COVID-19 exposure severity and PTS symptomatology. However, there was an association between emotion regulation and PTS symptomatology in Subgroup 2. Finally, participants in the high PTS symptoms subgroup (Subgroup 3) experienced the highest level of adjustment problems. Subgroup 3 comprised approximately 6.1% of the study samples and was distinguished by statistically significant relationships between expressive inhibition/cognitive reappraisal and PTS symptomatology, but no significant relationship between COVID-19 exposure and PTS symptoms. It is interesting to note that the effects of COVID-19 exposure on PTS symptomatology were only present in the mildly PTS symptoms subgroup (Subgroup 1). Both the moderate and high PTS symptoms subgroups ubiquitously experienced high levels of COVID-19 exposure, including family and friends infected with COVID-19, and therefore, the variation in exposure was low.

Notably, the subgroups were best distinguished by the associations between emotion regulation on PTS symptomatology. These results suggest that the more expressive suppression and the less cognitive reappraisal, the greater the PTS symptoms among maladjusted individuals, regardless of disease exposure level. However, in well-adjusted individuals, PTS symptomatology increased with greater levels of disease exposure, along with greater expressive suppression and less cognitive reappraisal. A previous study postulated that stress-related symptoms are positively associated with expressive suppression and negatively associated with cognitive reappraisal[28]. Consistent with his interpretation, participants in the current study with greater PTS symptomatology tended to use expressive suppression more frequently and cognitive reappraisal less frequently. These results suggest that inhibiting outward emotional reactions increases trauma-related psychopathology[11], while reframing perceptions of a stressful situation is an adaptive coping strategy[29].

After finding evidence for differential risks and protective effects related to PTS, we examined the effects of demographic variables on membership within each subgroup. First of all, in Subgroup 3, PTS symptomatology significantly decreased as age increased. On the one hand, it may be because seniors had experienced SARS, so they can cope with the stress better with former experience. On the other hand, it may be because the older generation uses the internet less than the younger generation, so they have less chance of experiencing information-overload, which stresses people up. Additionally, consistent with prior research, the current study found a gender difference in subgroup membership, with more women in the moderate PTS symptoms subgroup (Subgroup 2) than other subgroups. Furthermore, participants with children, or with siblings, or with family and friends being healthcare workers or infected with COVID-19 or having recently visited Wuhan, were more likely to be in the moderate or high PTS symptomatology subgroup (Subgroup 2 or 3). It seems that people with responsibilities and concerns for others, notably friends and family suffer most severely from PTS. Therefore, more attention needs to be paid to vulnerable groups such as the young, women and people with responsibilities and concerns for others.

While the current study contributes important data to our understanding of the psychological impacts of an epidemic, still there are several limitations. First, the current study gathered cross-sectional data, precluding any conclusions about causal relationships between COVID-19 exposure and psychopathological symptoms. Second, the current study only examined constructs reflecting psychopathology and did not include other measures of resilient functioning such as post-traumatic growth. Third, the current findings may be limited to the specific trauma type, thus further replications across various trauma types are warranted. Finally, data from the current study were collected solely through self-report questionnaires. Future studies should include data from clinical interviews.

Despite limitations, the current study describes a strong three-subgroup model for participants during a stressful epidemic. In addition, the results not only demonstrate more attention needs to be paid to vulnerable groups such as the young, women and people with responsibilities and concerns for others, but also highlight therapy for trauma survivors should involve encouraging emotional expression and cognitive reappraisal.

Conflict of interest statement

The authors declare that there is no conflict of interest.

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Authors' contributions

Authors ZYL and JY designed the study and wrote the protocol. Author JN participated in the collection and analysis of data, author HJJ managed the literature searches and wrote the first draft of the manuscript, and author JY completed the revising work. All authors contributed to and have approved the final manuscript.

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