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Impact of the COVID-19 pandemic on mental health in the general Chinese population: Changes, predictors and psychosocial correlates

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ABSTRACT

The current COVID-19 pandemic is not only a threat to physical health, but also brings a burden to mental health in the general Chinese population. However, the temporal change of mental health status due to pandemic-related stress in relation to protective and risk factors to hostility is less known. This study was implemented at two timepoints, i.e., during the peak and the remission of the COVID-19 pandemic. 3233 Chinese individuals participated in the first wave, and among them 1390 participants were followed in a second wave. The result showed that fear significantly decreased over time, while depression level significantly increased during the second wave compared to the first wave of the survey. Younger age, lower-income, increased level of perceived stress, and current quarantine experience were significant predictors of depression escalation. Younger people and individuals who had a higher initial stress response tended to show more hostility. Furthermore, the use of negative coping strategy plays a potential intermediating role in the stress-related increase in hostility, while social support acts as a buffer in hostility in the general population under high stress. As the whole world is facing the same pandemic, this research provides several implications for public mental health intervention.

1. Introduction

Since December of 2019, China has experienced a dramatic outbreak of a novel coronavirus disease 2019 (COVID-19), which rapidly spread in China and abroad. Wuhan, the center city of the epidemic, was locked down for 76 days from January 23 to April 8, and many other regions in China initiated first-level responses to major public health emergencies to curtail further disease transmission. Since the announcement of global pandemic threat by the World Health Organization (WHO) on March 11, 2020, many other countries initiated their lockdowns on their own. Compared to commonly investigated life stressors, the epidemic outbreak constituted an acute, large-scale and uncontrollable stressor with a long-term impact.

Numerous studies have investigated mental health consequences during other epidemic events (e.g., the 2003 Severe Acute Respiratory Syndrome (SARS), the 2009 H1N1 pandemic, and the 2014 Ebola epidemic). A pandemic can induce high levels of stress and measures taken to curtail contamination such as quarantine and social distancing aggravated mental health (Blakey et al., 2015; Bonanno et al., 2008; Cowling et al., 2010; Wu et al., 2009). Similarly, moderate to high level of psychological symptoms were reported among the general population in China during the COVID-19 outbreak (Tian et al., 2020; Wang et al., 2020a; Wang et al., 2020b). Only one study explored the change of mental health problem from the initial outbreak phase (end of January) to the epidemic's peak or acute phase (end of February) in the general public (n = 333) (Wang et al., 2020b). However, they could not investigate the temporal change of mental health problems at the individual level because they were not able to identify repeated respondents at the second time interval.

A commonly reported phenomenon in the media during this pandemic is an increase in hostility against people from such as medical profession, other nations or domestic ethnic minorities around the world (Wikipedia: List of incidents of xenophobia and racism related to the COVID-19 pandemic). In laboratory studies, a wide variety of stressors, like physical pain or minor daily hassles have been demonstrated to increase harmful social reactions such as aggression in both

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animal models and human participants (for reviews, see Sprague et al., 2011; Takahashi et al., 2018). However, the role of stress caused by social quarantine and constant low-level threat due to uncertainty during the pandemic and how this might relate to increased hostility is rarely studied. In the present study, hostility is defined as comprising feelings and/or behaviors characterized by anger expression such as aggression, irritability, rage, and resentment (Holi, 2003). In addition, it was proposed that stress per se is less crucial to mental health than coping strategies a person uses in response to stress (Compas et al., 2001). The construct of coping, the cognitive and behavioral strategies to meet the demands of stressful situations, has been considered an important mediator of the stress-emotion relationship (Folkman and Lazarus, 1988; Main et al., 2011). Coping can be described as negative/avoidant (e.g., distraction, withdrawal, wishful thinking, substance use) or positive/approach (e.g., problem-solving efforts, seeking information) (Day and Livingstone, 2001). Moreover, researchers have found that positive/approach coping is generally related with less psychological symptoms, while negative/avoidant coping is associated with more symptoms in the Chinese population (Ding et al., 2015; Zheng et al., 2012). Furthermore, it is important to examine the social factors that might protect an affected population from developing hostility. Social support of individuals by family, friends and even institutions have been widely demonstrated to have positive effects on both physical and psychological well-being, and also to have a moderating effect of stress on health, the so-called "stress-buffering hypothesis" (Cohen and Wills, 1985). According to this hypothesis, the moderation effect of social support on stress may arise through both processes depending on the amount of social support (main effect) and processes depending on the interaction of the stress level and the amount of social support (buffering effect). The buffering effect of social support, therefore, becomes more crucial as the stress level individuals perceived increases. Consistent with stress-buffering hypothesis, we predicted that social support might act as a buffer between stress and hostility.

Therefore, the first aim of the current study was to explore the effect of the COVID-19 pandemic on mental health of a general Chinese population sample during the course of acute pandemic activity the peak of the outbreak (January 31st to February 9th) to the epidemic's remission phase (15th to 28th of March) at the individual level. The second aim was to examine whether perceived stress level to the COVID-19 pandemic would predict an increase in hostility and whether coping strategies would play a potential intermediating role in the relationship between stress and hostility. It was expected that the underlying mechanism between stress and hostility would function through coping strategies, such that higher perceived COVID-19 stress would be related with an increased use of negative coping, which, in turn, would lead to more general hostility. The third aim was to identify protective psychosocial factor from the perspective of perceived social support in the relationship between perceived stress and hostility in the general population sample. According to the stress-buffering effect, individuals with high stress level benefit more from social support than individuals with low stress level (Cohen & Wills, 1985). Therefore, it was expected that social support would act as a protective factor between stress and hostility.

2. Methods

2.1. Procedure

This study was conducted from January 31st to February 9th (first wave of the survey, T1) and March 15th to March 28th (second wave of the survey, T2), which covered the time from the peak of the outbreak to the remission of COVID-19 epidemic in central China. As is shown in **Fig. 1**, at the first timepoint of this study, China was undergoing a difficult period during which the confirmed and suspected cases reached its peak, and pressure on the healthcare system was intensified. There was little information about the causal agents and available treatment methods for the disease. At the second timepoint of this study, the number of confirmed cases per day was already decreased since 2nd of March (https://covid19.who.int/region/wpro/country/cn), which was considered the remission phase of the COVID-19 epidemic in China. The information and data were provided on the official website of the National Health Commission of the People's Republic of China.

The inclusion criteria were being a Chinese citizen with junior high education or higher. Questionnaires were randomly distributed nationwide in China through a web-based survey company ('SurveyStar', Changsha Ranxing Science and Technology, Shanghai, China). To ensure data quality, there were six filler items (e.g., "I usually feel that winter is hotter than summer") in the survey to exclude invalid responses. In total, 3,233 Chinese individuals participated in the first wave of survey (T1). Among these 3233 respondents, 1,390 (retention rate: 43%) participated in the follow-up second wave of survey (T2). The final analytic sample consisted of 1,390 participants who participated in both the first and the second waves. Approximately 25% (n = 403) of the participants were from Hubei Province in which Wuhan is the capital city. All the other participants were from the 29 provinces and regions in mainland China. Participants who answered all the questions were paid 25 Yuan as compensation for the first and second waves of the survey separately. Participants were asked to fill in the questionnaire according to their current situation in a relatively quiet environment to avoid interference as much as possible. They were also informed that their personal information and responses will be kept anonymous and confidential. This study was approved by the Ethics Committee of Peking University. All participants provided electronic informed consent before the commencement of the two waves of survey.

2.2. Measures

To assess the perceived stress to the COVID-19 epidemic, Perceived Stress Scale 10-item version (PSS10) was used during the first and second waves of the survey. To address the first aim, we included and Psychological Questionnaire for Emergent Events of Public Health (PQEEPH) during the first and second waves of the survey. For the second aim, we included Hostility Subscale from Symptom Check-List 90 (SCL-90) and Simplified Coping Style Questionnaire (SCSQ) during the second wave of the survey. For the third aim, we included Perceived Social Support Scale (PSSS) during the second wave of the survey. All the questionnaires were described in detail in the following part.

2.2.1. PSS10

The PSS10 includes 10 items assessing stress for the past one month during the COVID-19 epidemic. This scale was originally compiled by Cohen et al. (1983) and the revised Chinese version has been demonstrated to have good reliability and validity (Yang & Huang, 2003). An example item is "during the outbreak, how often have you felt that you were unable to control the important things in your life". Each item is rated from 1 (not at all) to 5 (very much). The average score is calculated by the sum of each item score divided by the total number of items (range: 1∼5). The higher the score, the more stressed the respondent is. The PSS10 demonstrated good internal consistency (α = .826 in the first survey and α = .819 in the second survey) in the current sample.

2.2.2. PQEEPH

The mental health status during the COVID-19 pandemic was measured by the PQEEPH in the first and second waves. This scale is adapted from the SARS Psychological Behavior Questionnaire (SARS-PBQ) (Gao et al., 2004), which includes five dimensions: depression, fear, compulsion-anxiety, neurasthenia and hypochondria. The range of each dimension is from 1 to 4. Considering that some items of SARS-PBQ were made specifically for SARS epidemic, we have adapted the

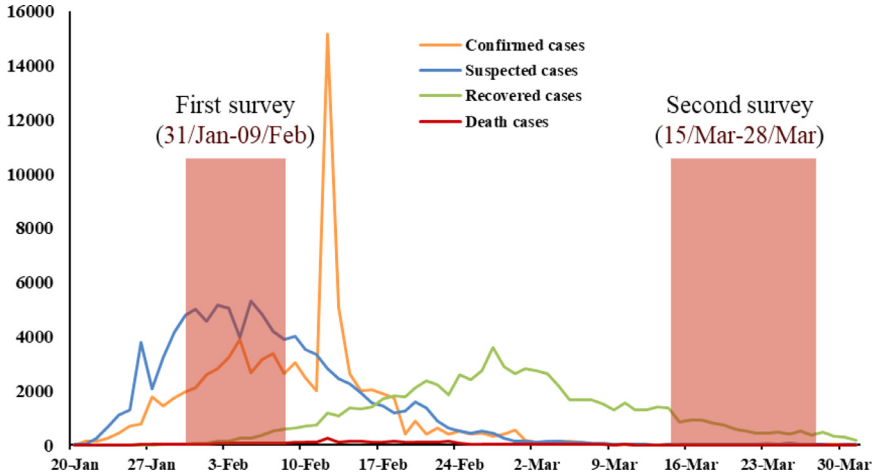

Fig. 1. Evolution of the COVID-19 epidemic in China from January 20 to March 30. The lines indicate case counts per day of confirmed cases in yellow (note the spike of confirmed case on 14th of February was due to a change in diagnostic criteria from only by test kits to clinical (radiological) diagnosis of patients), suspected cases in blue, recovered cases in green and casualties in red.

content of these questions to fit the current context of COVID-19 epidemic. For example, the item 'when it comes to something related to SARS, I feel scared and my heart beats fast' was revised into 'when it comes to something related to COVID-19, I feel scared and my heart beats fast'. In the study, the internal consistency coefficients of the five dimensions (depression, fear, compulsion-anxiety, neurasthenia, and hypochondria) were (a) α = .809, .722, .714, .722 and .656 in the first survey; (b) α = .803, .734, .686, .710 and .654 in the second survey.

2.2.3. Hostility

The Hostility subscale of the SCL-90 (Derogatis & Savitz, 1999) was used to measure hostility levels in the second wave. This hostility subscale comprises 6 items such as temper outbursts that you could not control in the past one week, and each item is assessed by a 5-point Likert scale (0 = "not at all" to 4 = "all the time"). The average score is calculated by the sum of each item score divided by the total number of items (range: 1–5). An example item is "how often did you get into frequent arguments within the last week". It reflects the respondents' hostility from three aspects: thoughts, emotion and behavior. In the current sample, the internal consistency coefficient is α = .858.

2.2.4. SCSQ

Coping style has been widely investigated around the world. However, the difference in research aims contributed to various evaluation tools for coping style. In China, one of the main understandings of coping style is defined it as the tendency an individual is used to adopting. Based on this, Xie (1998) developed the SCSQ by refering to the rules of Folkman and Lazarus' (1988) Ways of Coping Questionnaire (WCS). The SCSQ consists of 20 items for coping styles which is further divided into two dimensions, i.e., negative and positive coping style (Xie et al., 1998). The average score is calculated with the range of positive coping from 1 to 5 and of negative coping from 1 to 7. For example, "self-consolation" and "accepting reality" is classified as negative coping and "ask help from family and friends" is considered as positive coping. The SCSQ has been widely applied in various studies in Chinese population (e.g., Lin et al., 2020). For example, negative coping style was found to be associated with higher suicide risk in Chinese patients with major depressive disorder (Lin et al., 2020) and with disrupted brain network in older Chinese adults (Liu et al., 2015), while positive coping style was associated with larger posttraumatic growth among Wenchuan earthquake survivors (Guo et al., 2017). This scale was to examine respondent's coping styles in the second wave. In our study, the internal consistency coefficients of the positive and negative coping style subscale were α =.796 and .640, respectively.

2.2.5. PSSS

Based on the Multidimensional Scale of Perceived Social Support (Zimet et al., 1988), the Chinese version of perceived social support scale was revised by Jiang (2001). Considering the characteristic of "collectivism" in Chinese culture, the Chinese PSSS includes not only supports from family and friends, but also supports from others government. For example, "when we need help, our nation's medical forces can be the first to provide help". This scale was used to measure the subjective and perceived social support of participants in the second wave. The degree of support is rated and average score is calculated (range: 1–7), with higher score indicating more perceived social support. The internal consistency of our research is α = .828.

2.3. Statistical analyses

All the statistical analysis was conducted by IBM SPSS Statistics, version 24.0 (IBM Corp., Armonk, NY).

For the first aim, the change of perceived stress and mental health during the COVID-19 from T1 to T2 was analyzed by paired sample *t*-test. To prevent multiple comparisons problem, the adjusted *p* value ($p < 0.01$) for the five dimensions of PQEEPH was applied. Furthermore, hierarchical regression analyses were performed to explore the predictive effects of demographic factors, quarantine experience and perceived stress on mental health change over time (from Wave 1 to Wave 2) (see details in the Result part).

For the second and third aim, the intermediating role of coping styles and the moderating role of perceived social support on hostility were analyzed by PROCESS macro (Model 1 and Model 4). In these models, we controlled for gender, age, education, monthly income, and quarantine experience (T1 and T2). All continuous variables were standardized and the interaction terms were computed from these standardized scores. The bootstrapping method produces 95% bias-corrected confidence intervals of these effects from 5000 resamples of the data. Confidence intervals that do not include zero indicate effects that are significant (Hayes & Scharkow, 2013). The standard error of the linear regression model is estimated using HC3 as proposed by Davidson and MacKinnon (1993).

3. Results

3.1. Characteristics of participants

Demographic description of the respondents who participated in the two waves of the survey (n = 1390) are shown in the **Table 1**. Majority of respondents from these two surveys were at young adulthood with a mean age of 30.72 years, well educated (75.2% ≥ bachelor degree) and average income (Income in Yuan per month). Due to suspected or confirmed infection, 89 respondents at T1 and 331 respondents at T2 reported quarantine experience. The mean, Standard Deviation (SD)

Table 1
Demographic characteristics of the respondents who participated in the two waves of the survey (N = 1390)

Variable	Mean (SD) or number (%)
Gender	
Male	595 (42.8%)
Female	795 (57.2%)
Age	30.72 (8.86)
Education	
High school	103 (5.6%)
Associate degree	242 (17.4%)
Bachelor degree	927 (66.7%)
Master and above	118 (8.5%)
Monthly income (Yuan)	
0	206 (14.8%)
<2000	76 (5.5%)
2001–5000	304 (21.9%)
5001–10000	519 (37.3%)
10001–20000	215 (15.5%)
20001–50000	54 (3.9%)
50001–100000	12 (0.9%)
>100000	4 (0.3%)
Quarantine experience	
T1	89 (6.4%)
T2	331 (23.82%)

Table 2
The mean, standard deviation (SD) and scoring range of all measures at T1 and T2.

Index	Mean	SD	Range Min	Max
Perceived stress				
T1	2.559	.597	1.100	4.500
T2	2.360	.545	1.000	4.500
Depression				
T1	1.556	.514	1.000	3.833
T2	1.600	.520	1.000	3.833
Fear				
T1	2.392	.653	1.000	4.000
T2	2.217	.603	1.000	4.000
Compulsion-anxiety				
T1	1.450	.416	1.000	3.333
T2	1.435	.426	1.000	3.333
Neurasthenia				
T1	1.658	.596	1.000	4.000
T2	1.675	.588	1.000	4.000
Hypochondria				
T1	1.717	.690	1.000	4.000
T2	1.675	.656	1.000	4.000
Positive coping	3.373	.553	1.273	5.000
Negative coping	2.739	.523	1.000	4.500
Perceived social support	5.686	.681	2.636	7.000
Hostility	1.728	.680	1.000	4.667

and scoring range of all measures at T1 and T2 are shown in the **Table 2**.

3.2. Changes in perceived stress and mental health from T1 to T2

Fig. 2 presents the differences for perceived stress and mental health during the COVID-19 epidemic from T1 to T2. The paired sample t-test indicated that the levels of perceived stress (t = 14.689, p < .001, d = .348) decreased significantly from T1 to T2. For the five dimensions of PQEEPH, fear (t = 11.514, p < .001, d = .278) decreased significantly from T1 to T2. On the contrary, there was an increase in the level of depression (t = -3.362, p < .01, d = .085) from T1 to T2. However, there were not significant differences in the levels of hypochondria (t = 2.354, p > .01, d = .062), compulsion-anxiety (t = 1.453, p > .01, d = .036) and neurasthenia (t = -1.17, p > .01, d = .029) between the two surveys.

3.3. The predictors of depression level at second wave of the survey (T2)

To explore predictors of depression level at T2, a hierarchical regression model was used. Specifically, for independent variables, depression level and quarantine experience measured in Wave 1 were placed in the first step as the controlled variables; demographic variables (i.e., gender, age, education and monthly income), which were all measured in Wave 1, were entered in the second regression step; and increase in perceived stress as well as quarantine experience measured in Wave 2 were placed in the third step. As **Table 3** shows, after controlling initial depression level (depression_T1) and initial quarantine experience (quarantine_T1), ΔPSS10 (β = .194, p < .001) significantly predicted depression at T2, i.e., higher perceived stress from T1 to T2 is associated with higher depression level at T2. Quarantine experience at T2 (β = - .063, p < .05) significantly predicted depression at T2, such that respondents who have the recent experience of quarantine reported higher depression level at T2. Furthermore, age (β = - .056, p < .05) and monthly income (β = - .054, p < .05) were also significant predictors, indicating that younger people and individuals with lower income experience worsening depression symptoms.

3.4. Coping style as the potential intermediator of stress-hostility relationship

There was a significantly positive correlation between PSS10 at T1 and hostility at T2 (r = .382, p < .001). In the hierarchical model, initial perceived stress and quarantine experience measured in Wave 1 were placed in the first regression step; demographic variables (i.e., gender, age, education and monthly income), which were all measured in Wave 1, were entered in the second regression step; and quarantine experience measured in Wave 2 was placed in the third step. The result (see **Table 4**) showed that the level of perceived stress at T1 (β = .366, p < .001) significantly predicts the higher level of hostility at T2. Additionally, age (β = - .082, p < .001) negatively predicts the hostility such that younger people show higher hostility in general.

The level of hostility at T2 was positively correlated with negative coping (r = .287, p < .001) and negatively correlated with positive coping (r = - .123, p < .001), which provided a precondition for testing the intermediating effect of coping styles of stress-hostility relationship.

A mediation model was built in which perceived stress at T1 was treated as a predictor, the level of hostility at T2 as the outcome variable, negative and positive coping as mediators, and demographic variables (gender, age, education, and monthly income) as covariates.

This mediation model was tested using the PROCESS macro (Model 4) developed by Hayes and Scharkow (2013). As reported in **Table 5**, perceived stress at T2 is negatively correlated with positive coping (β = - .167, p < .001) and positively correlated with negative coping (β = .055, p < .05). Furthermore, positive coping at T2 negatively predicted the level of hostility at T2 (β = - .161, p < .001), while negative coping at T2 positively predicted the level of hostility at T2. Furthermore, positive coping and negative coping at T2 independently intermediates the relationship between perceived stress at T1 and the level of hostility at T2 (see *Result* in supplementary material).

The results of mediation effect are summarized in **Fig. 3**. To summarize, positive coping negatively intermediates the effect of stress on hostility, while negative coping positively intermediates the effect of stress on hostility.

3.5. Perceived social support as the moderator of stress-hostility relationship

There was a significantly positive correlation between PSS10 at T1 and hostility at T2 (r = .382, p < .001). Meanwhile, perceived social support at T2 was negatively correlated with the level of hostility at T2 (r = - .208, p < .001). Therefore, the PROCESS macro (Model 1) by Hayes and Scharkow (2013) was used to test whether perceived social support at T2 could moderate the relationship of perceived stress at T1

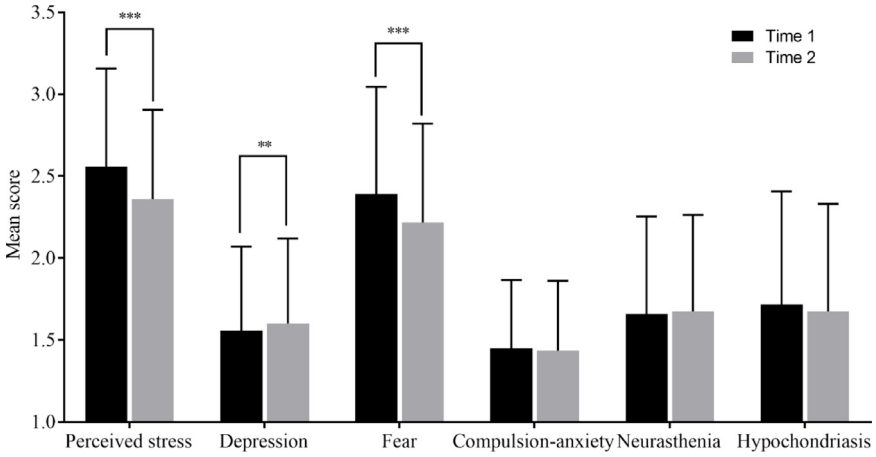

Fig. 2. Perceived stress and mental health during the COVID-19 epidemic between T1 (January 31st ~ February 9th) and T2 (March 15th ~ 28th); $^{***}p < .001$; $^{**}p < .01$.

Table 3
Hierarchical regression analysis in predicting depression at T2.

Variables	*B*	SE	*β*	*t*	*R* square	Adjusted *R* square	*R* square change	*F*	*p*
Step 1					.310	.309	.310	311.755	.000
Depression_T1	.559	.023	.552	24.722***					
Quarantine_T1	-.063	.030	-.047	-2.096*					
Step 2					.321	.318	.011	109.075	.000
Depression_T1	.556	.022	.549	24.733***					
Quarantine_T1	-.053	.030	-.040	-1.779					
Gender	.021	.024	.020	.883					
Age	-.004	.002	-.070	-2.625**					
Education	.011	.016	.016	.698					
Monthly income	-.016	.010	-.043	-1.587					
Step 3					.362	.359	.041	98.146	.000
Depression_T1	.572	.022	.565	26.121***					
Quarantine_T1	-.049	.030	-.036	-1.624					
Gender	.024	.023	.023	1.032					
Age	-.003	.002	-.056	-2.181*					
Education	.022	.016	.032	1.389					
Monthly income	-.020	.010	-.054	-2.042*					
Δ PSS10	.200	.022	.194	8.945***					
Quarantine_T2	-.061	.021	-.063	-2.853**					

Note: Δ PSS10 = Perceived stress at T2 minus perceived stress at T1.
* $p < .05$;
** $p < .01$;
*** $p < .001$.

Table 4
Hierarchical regression analyses of gender, age, education, income and perceived stress at T1 in predicting hostility at T2

Variables	*B*	SE	*β*	*t*	R square	Adjusted R square	R square change	*F*	*p*
Step 1					.146	.145	.146	118.899	.000
Perceived stress_T1	.432	.028	.379	15.189***					
Quarantine_T1	-.048	.044	-.027	-1.087					
Step 2					.154	.150	.007	41.848	.018
Perceived stress_T1	.422	.029	.370	14.725***					
Quarantine_T1	-.037	.044	-.021	-.852					
Gender	.055	.035	.040	1.567					
Age	-.007	.002	-.085	-2.850**					
Education	-.031	.023	-.035	-1.348					
Monthly income	.024	.015	.050	1.640					
Step 3					.155	.151	.001	36.237	.127
Perceived stress_T1	.417	.029	.366	14.503***					
Quarantine_T1	-.022	.045	-.012	-.481					
Gender	.054	.035	.040	1.552					
Age	-.006	.002	-.082	-2.745***					
Education	-.029	.023	-.033	-1.240					
Monthly income	.024	.015	.048	1.600					
Quarantine_T2	-.049	.032	-.039	-1.526					

Table 5
The parallel mediation model of positive and negative coping at T2 between perceived stress at T1and hostility at T2.

Predictors	PC T2				NC T2				Hostility T2			
	β	SE (HC3)	*t*	*p*	*β*	SE (HC3)	*t*	*p*	*β*	SE (HC3)	*t*	*p*
Gender	.067	.030	2.448	.015	.055	.029	1.983	.048	-.105	.034	1.437	.151
Age	.009	.002	.289	.773	.068	.002	2.162	.031	-.024	.002	-3.665	.000
Education	.041	.021	1.376	.169	-.015	.019	-.542	.588	.074	.023	-.899	.369
Income	.118	.013	3.729	.000	-.016	.013	-.439	.661	.036	.015	2.429	.015
PSS10 T1	-.167	.026	-5.967	.000	.169	.025	5.837	.000	.297	.030	11.344	.000
PC T2									-.161	.031	-6.471	.000
NC T2									.286	.035	1.769	.000
F (HC3)	12.444***				8.353***				51.258***			
R	.215				.185				.477			
R^2	.046				.034				.228			

Note. PSS10 = Perceived stress; T1 = First survey; T2 = Second survey; NC T2 = Negative coping scores at T2; PC T2 = Positive coping scores at T2.

and the level of hostility at T2. As displayed in Table 6, the interaction effect of perceived stress at T1 and perceived social support at T2 could negatively predict the level of hostility at T2 (β = - .081, p < .001).

To further explain the interaction effect, the relationship between perceived stress at T1 and hostility at T2 was plotted. As the moderator, the levels of perceived social support at T2 was divided into low (M - SD) and high (M + SD), respectively. The results showed that as the level of perceived social support at T2 reduced from high to low, the predictive effect of perceived stress at T1 on the level of hostility at T2 was gradually strengthened, and β increased from .241 (p < .001) to .402 (p < .001) (See Fig. 4). Therefore, perceived social support buffered the relationship between elevated perceived stress and elevated hostility.

Table 6
The moderating effect of perceived social support (T2) between perceived stress (T1) and hostility (T2).

Predictors	*β*	SE (HC3)	*t*	*p*
Gender	.100	.049	2.064	.039
Age	-.009	.003	-2.638	.008
Education	-.020	.035	-.580	.562
Monthly income	.046	.022	2.107	.035
Perceived stress (T1)	.322	.026	12.254	.000
Perceived social support (T2)	-.235	.028	-8.359	.000
Perceived stress (T1) × Perceived social support (T2)	-.081	.021	-3.825	.000
F	53.164			
R	.468			
R^2	.219			

4. Discussion

In the current study, we investigated the temporal change of mental health status in a sample of the Chinese population from the peak to the remission phase of the COVID-19 pandemic. We found that compared to the peak phase, levels of perceived stress and fear decreased, while depression levels were significantly increased during the remission phase. Regression analysis showed that younger age, lower income, higher perceived stress to the COVID-19 pandemic as well as current quarantine experience (measured at T2) are risk factors of depression deterioration. Furthermore, we found that the younger age and initial perceived stress during the peak phase predict more hostility in its remission phase. Our mediation model showed that positive coping negatively and negative coping positively intermediate the relationship between stress and hostility, which underscores the importance of adaptive coping strategies in the mitigation of aggressive reactivity to a global and diffuse threat. Social support also buffered the effect of perceived stress on later hostility.

With the decreasing number of confirmed cases and death cases, the level of fear response to the COVID-19 also decreased significantly at the stage of the remission phase. This decrease likely is related to a mild recovery from fear and concerns about the risk of being infected by the virus as well as potentially habituation effects to the changed environment. The reduction in fear could be due to a perceived effectiveness of the implemented measures and concurrent people's confidence in the ability to contain the spread of COVID-19 by strict regulations, strong enforcement of these and community/citizen compliance. After initial panic due to misinformation, lack of scientific certainty and speculations about potential trajectories at an early stage, governmental action, such as improved medical support logistics from Mid-February onwards might have contributed to easing of mental burden (Hua & Shaw, 2020).

Unexpectedly, we found that anxiety and neurasthenia maintain stable and depression is even aggravated at the time of remission of the pandemic in the general population, although the threat from COVID-19 was largely contained at this time. Younger age, lower income,

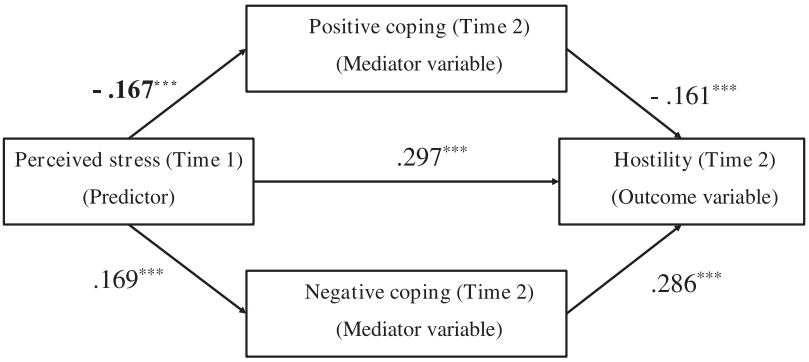

Fig. 3. Mediation model of coping styles at T2 in the relationship between perceived stress at T1 and the level of hostility at T2. Values are standardized coefficients. *p < .05, **p < .01, ***p < .001.

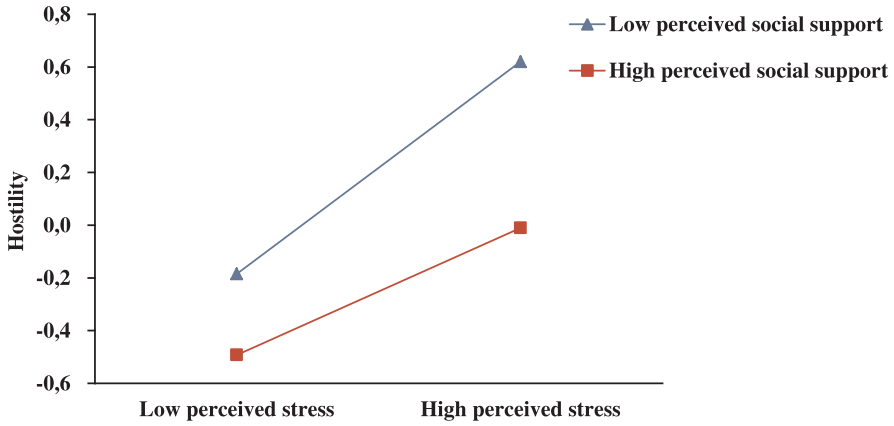

Fig. 4. Perceived social support as a moderator of the relationship between perceived stress (T1) and hostility (T2). Functions are graphed for two levels of the perceived social support (T2); one standard deviation above the mean and one standard deviation below the mean.

higher perceived stress, and current quarantine experience were associated with depression deterioration. Similarly, a cross-sectional study on the impact of the 2003 SARS epidemic in Taiwan found 4% prevalence of depression one month after the epidemic ended (KO et al., 2006). Jalloh and colleagues (2018) found that symptoms of anxiety-depression were common even after one year after Ebola response in the general population in Sierra Leone. However, due to the cross-sectional design, these two studies could not clarify whether these symptoms were elevated above the level as when the pandemic occurred. An assessment of hospital employees in China found that compared to a non-segregated sample, the experience of being segregated during SARS was associated with high depressive symptoms three years after the epidemic (Liu et al., 2012). With a prospective design, our study provided insights for depression development under the epidemic in the general population. Individuals who are young, economically disadvantaged, who have been socially isolated or quarantined and who show a strong initial stress response might be particularly at risk for elevated depression in the aftermath of such a pandemic.

We found that younger people expressed more hostility in this COVID-19 epidemiological situation, which might be due that younger adults adopt ineffective emotion regulation supported by cognitive control (Jackson and Finney, 2002). After reviewing data from structural and functional brain imaging, Nashiro and colleagues (2012) found that with preserved amygdala in older adults, they show greater prefrontal cortex activity than younger adults while engaging in emotion-processing tasks. Furthermore, individuals perceived higher stress of the COVID-19 pandemic at the peak of the outbreak predicted more hostility at the remission phase of the epidemic. This is consistent with Berkowitz's (1990) model that stress exposure will lead to hostility to the extent that the stressor is perceived as aversive. For example, various experimental studies have linked state hostility to a wide variety of stressors, especially physical pain (Anderson et al., 1996; Berkowitz 1993). Furthermore, when experiencing high and persistent stress levels, individuals frequently withdraw from social interactions and become irritable and hostile (Sandi and Haller, 2015). When it comes to the pandemic-related stress, it was long argued that crucial life conditions that threaten physical well-being may lead to hostility toward others in order to protect the self from contagious pathogens (Murray and Schaller, 2016; O'Shea et al., 2020).

However, our mediation model showed that relations between perceived stress and hostility could be accounted for by the coping strategies individuals selected. This is consistent with stress and trauma literature that the association between life stress and psychological adjustment is strongly mediated by coping strategies (Runtz and Schallow, 1997; Tremblay et al., 1999). Positive coping, such as problem-solving efforts, seeking information and cognitive reappraisal, involves focusing on the cause of the stress and attempting to actively do something to mitigate the stress (Carver et al., 1989). Individuals with positive coping strategies believe they have more control over the situation and might in turn develop fewer hostile responses to a stressful situation. Negative coping, such as denial, withdrawal, wishful thinking and substance use, involves emotion-focused passive coping strategies in an attempt to reduce the emotional stress elicited by a stressful situation. Individuals with passive coping believe they have little control over the situation (Folkman and Lazarus, 1980; 1988), and therefore display more hostility to the environment.

Furthermore, the relationship between perceived stress and hostility was moderated by social support, which was consistent with the stress-buffering effect that social support has. Compared to individuals with lower levels of stress, individuals with higher levels of stress show a more substantial and beneficial influence of social support (Cohen and Wills, 1985). Research has consistently demonstrated that social support mitigates emotional distress under stress. For example, the social network size and the availability of social support can buffer the association between life stress and depression, anxiety and life satisfaction (Auerbach et al., 2011; Santini et al., 2015; Sperry and Widom, 2013). Given the social quarantine and stigmatization in the recession of the COVID-19 pandemic, social support becomes especially important for psychosocial adjustment of affected individuals. With support from friends and family and even from institutions, individuals who are under high perceived stress related to the virus might feel more connected with society and thus have fewer hostile responses towards others.

Our study provides some implications for public mental health. First, it is crucial to develop and implement effective screening procedures at the institutional level to identify risk and resilience factors to provide precise intervention (Yang et al., 2010). In this context, we identified that younger people are at risk of both depression and hostility in the aftermath of the COVID-19 pandemic. Second, the effect of pandemic-related stress on emotional disturbance (especially depression) suggests the importance of early individualized psychological intervention in the general population, with a focus on individuals who are economically disadvantaged, individuals who have been quarantined and individuals that exhibit high levels of stress. Third, positive coping strategies as well as social support should be encouraged even in the context of social distancing.

There are some limitations to our study. First, we investigated a Chinese sample only to assess the temporal dynamics of mental health during this pandemic, which limits generalizability to other countries. In the same vein, the questionnaires we used here are not for clinical diagnosis and include constructs that capture culturally-dependent phenomenon such as neurasthenia, social support from the government level. Second, all the constructs in the current study were assessed by

self-report. However, more and more studies reach the consensus that it is the subjective appraisal rather than the stressor itself that has large impacts on mental and physical health (Mathur et al., 2016; Pascoe and Smart Richman, 2009). Third, the retention rate from the first wave to the second wave in our study was low (approximately 43%). The respondents who participated in the two waves were mainly young and well-educated who might also be more physically and psychologically resilient. Older and socio-economically disadvantaged people might constitute a population that is more at risk for severe trajectories of the disease and also consequently might be more prone to perceived stress.

5. Conclusion

Despite these limitations, our study tracked the psychological change at the individual level during the peak and remission phase of the COVID-19 epidemic in China. Fear significantly decreased while depression level significantly increased over the course of the pandemic. We identified that younger age, lower income, higher perceived stress, and current quarantine experience are risk factors for depression deterioration. Younger age and higher initial stress predicted higher hostility, which was mediated by negative coping style. Furthermore, social support can buffer the effect of stress on hostility. Our results might provide implications for public mental health intervention.

Author contribution

J.H.Wu and Y.Q.Gan developed the study concept. All authors contributed to the study design. L.L.Yan and H.X.Duan performed the data analysis and interpretation under the supervision of J.H.Wu and N.Kohn. L.L.Yan and H.X.Duan drafted the manuscript, and N.Kohn provided critical revisions. All authors approved the final version of the manuscript for submission.

Declaration of Competing Interest

The authors declare no competing interests.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.psychres.2020.113396.

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