ORIGINAL RESEARCH

Risk Perception and Public Pandemic Fatigue: The Role of Perceived Stress and Preventive Coping

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Purpose: This study explores the status of pandemic fatigue, predictors, and their mechanisms of action based on a stress-response framework and a parallel model of future-oriented response.

Patients and methods: Study 1 investigated 8426 Chinese adult residents' understanding of and willingness to cooperate with the pandemic prevention and control policies and Study 2 surveyed 1635 Chinese residents on their activeness of pandemic prevention and control (APPC), pandemic risk perception, perceived stress, and future-oriented coping.

Results: Study 1 found that public understanding of and willingness to cooperate with prevention policies were significantly lower in 2022 than in 2020 and 2021. Study 2 found that risk perception negatively predicted the APPC; perceived stress and preventive coping significantly mediated the relationship between risk perception and APPC; but perceived stress and proactive coping did not significantly mediate the relationship between risk perception and APPC.

Conclusion: This revealed an increase in public fatigue in the third year of the pandemic. Pandemic fatigue can be predicted by pandemic risk perception, but the direct pathway of action is not significant and requires the mediation of perceived stress and preventive coping.

Keywords: pandemic fatigue, risk perception, stress, proactive coping, preventive coping

Introduction

From the Black Death in Europe to the bubonic plague outbreaks, to the global SARS virus at the end of the last century, humanity has always had to deal with public pandemics.[1] Although the World Health Organization (WHO) announced that the novel coronavirus pneumonia (COVID-19) is no longer a "global health emergency" in May 2023, the event has been going on for more than three years. During the three-year-long pandemic response, does the public experience different levels of psycho-behavioral reactions, such as pandemic fatigue,[2] which in turn leads to changes in social response policies? Therefore, studying pandemic fatigue and its occurrence mechanisms is important for us to avoid public fatigue in the future and thus better cope with an unknown public pandemic.

WHO refers to this negative psychological phenomenon as pandemic fatigue and describes it as a lack of activeness of the public to engage in protective behaviors and seek information related to the pandemic due to unresolved and persistent adversities in their lives.[2,3] It is a natural long-term response of individuals due to the risk stimulus caused by the pandemic.[4,5] The pandemic fatigue may deprive individuals of their coping energy and activeness, and may even generate a deep-seated sense of despair,[6] which has a significant impact on an individual's physical, emotional, and even economic status,[7] and also severely hampers the process and effectiveness of pandemic prevention and control efforts, as well as social and economic

growth. This paper aims to examine the current situation of pandemic fatigue through two studies and explore the predictive mechanisms of pandemic fatigue based on a stress-response model to provide a theoretical reference to address the phenomenon of pandemic fatigue and to facilitate the smooth implementation of pandemic prevention and control efforts.

Theoretical Background
Stress-Response Model

Lazarus' cognitive interaction theory[8] suggests that when faced with a stressor, individuals process the harm, threat, or challenge they face through cognitive appraisal processes and coping processes,[8,9] and respond with appropriate behaviors. The cognitive appraisal process theory proposes that stress generation relies on the cognitive appraisal of the situational events faced by an individual, including the relationship of the event to oneself and the appraisal of coping resources. The coping process is changing, varying over time and with the task, and coping styles change with stressful situations and over time.[10] Thus, a process model of stress response can be distilled, ie, the process of stressors - assessment - coping - outcome.

Pandemic fatigue is an important outcome of the chronic stress response under the pandemic.[4] The uncertainty and urgency of the occurrence of public health emergencies such as Corona Virus Disease 2019, combined with the significant adverse effects on human health, the economy, and society, make them a massive stressor in the present day,[11] and individuals are highly susceptible to stress reactions such as panic and anxiety.[12] Risk perception of the pandemic can directly drain an individual's psychological resources, and brief risk perception can help individuals cope. However, persistent risk stimuli may overly deplete individuals' psychological resources and affect their participation in pandemic prevention and control behaviors,[13] leading to pandemic fatigue (including the effects of understanding and willingness to cooperate with the pandemic control policies, as well as the effects of activeness of pandemic prevention and control). Therefore, the stress-response process model can be used to analyze the effects and mechanisms of persistent risk stimuli on pandemic fatigue.

Hypothetical Development
Risk Perception and Public Pandemic Fatigue

Risk generally consists of two components: one is the materially objective risk, and the other is the risk that is constructed within the public, ie the perceived risk.[14] Risk perception is used to describe people's attitudes toward objective risk, "the subjective judgment of an individual or a particular group about environmental risk in a context of limited and uncertain information".[15] As a result, different individuals do not perceive the same actual risk in the environment in the same way.[16] Individuals with different perceptions of risky stimuli may also have different stress response outcomes. As risk perception from unexpected public events can directly deplete an individual's psychological resources, it can negatively impact an individual's work attitudes and behaviors[13] and show emotional or cognitive-behavioral responses such as depressed mood and developing burnout.[17] It has been found that the public's perception of risk affects their compliance with regulations.[18] Individuals who develop different perceptions of risk may also have different levels of pandemic fatigue. Based on this, the following hypothesis is proposed.

H1: Pandemic risk perception positively predicts pandemic fatigue.

The Role of Perceived Stress

Pandemic fatigue has also been interpreted as a form of "social burnout",[19] a state of emotional, physical, and mental exhaustion, or even negative evaluation, caused by prolonged stress.[20] Stress, also known as pressure, refers to the range of physiological and psychological responses that occur when an individual is subjected to real or potential threats to the body and mind to restore homeostatic balance.[21] Pressure is evident when individuals perform work or tasks in unpredictable and uncontrollable risk scenarios.[22] The job demands and resources model (JD-R) theory suggests that pressure can initiate the process of depletion and produce burnout.[23] Empirical research has found that pressure is positively associated with personal burnout and work-related burnout,[24] ie public perceptions of pressure may negatively predict pain fatigue. And perceived stress is more often used as a mediating variable to influence pandemic fatigue.[25] Furthermore, based on the stress-response framework, perceptions of the risk of viral infection and concomitant stressors

such as social distance can cause individuals to experience persistent pressure and consequently responses such as burnout. Therefore, the following hypotheses are proposed in this study.

H2: perceived stress positively predicts public pandemic fatigue.

H3: perceived stress mediates the relationship between pandemic risk perception and pandemic fatigue.

The Role of Perceived Stress

In addition, Lazarus' cognitive interaction theory suggests that in addition to cognitive appraisal, coping is an important mediating variable in the process by which stressors cause individuals to produce stress-related responses, and is the cognitive and behavioral effort that individuals choose to make based on their resources after assessing the stressor.[8] In the era of COVID-19, concerns about the future, a sense of uncertainty, and insecurity have become an important theme for the public.[26,27] Each of these perceptions may undermine public vigilance about the pandemic and adherence to preventive measures against potential risks.[27,28]

Future-oriented coping is the prevention of potential risks in the future, ie individuals take measures to cope with potential stressors in their future lives in advance.[29] Future-oriented coping involves both proactive coping and preventive coping. Proactive coping is the effort that individuals make to facilitate the achievement of challenging goals and their growth, while preventive coping is the effort that individuals make to cope with potential events in the hope of reducing the severity of the impact of negative events before they occur.[30] Some researchers have argued that there are different motivations for these two coping strategies.[31] Firstly, preventive coping is motivated by an assessment of threat, whereas proactive coping is motivated by an assessment of challenge; in addition, the level of anxiety associated with proactive and preventive coping differs, with higher levels of anxiety associated with preventive coping.[31,32] Proactive preventive coping corresponds to different risk stimuli and cognitive evaluation. For this reason, Gan[30] has summarized a parallel model of future-oriented coping. This model suggests that preventive and proactive coping exist independently, with a parallel relationship mediating the impact of primary assessment on coping outcomes.[32,33] Based on this theoretical model, this study further explores the role of proactive and preventive coping in the relationship between risk perception and pandemic fatigue.

As discussed earlier, feelings of the pressure of variable mobility and unpredictability of the pandemic can further exacerbate worry fatigue.[6,27] Preventive coping focuses on threatening stressors that are relatively distant and have a high degree of uncertainty (eg losing a job or contracting a virus), where individuals accumulate resources in advance to minimize the damage caused by the stressor.[31] Thus, in the process of risk perception-stress feelings-pandemic fatigue, preventive coping, seen as threat management, may have a positive effect.[34] According to a parallel model of future-oriented coping, preventive coping mediates the relationship between perceived stress and coping outcomes,[32,33] ie individuals will take more preventive coping measures [eg hand washing[35]] when faced with a threat, thereby reducing fatigue. Therefore, the following hypothesis is proposed in this study.

H4a: perceived stress and preventive coping are playing a chain mediating role in the relationship between pandemic risk perception and pandemic fatigue.

According to parallel models of future-oriented coping, both proactive and preventive coping mediate the relationship between perceived stress and coping outcomes.[30,32] However, it is important to note that proactive coping focuses on challenging stressors and aims to promote self-improvement and growth.[29,36] Therefore, when considering the role of proactive coping in the process of risk perception-stress feelings-pandemic fatigue, the types of stressors presented by the pandemic should be considered. Unlike problem-focused or emotion-focused preventive coping, proactive coping seeks to resolve stressful situations or reduce the individual's negative feelings towards stressors,[37] and it can be seen as a form of goal management.[34] Proactive coping corresponds to stressors where future stressful events are relatively clear and individuals can take a more proactive and purposeful approach to coping than preventive coping.[29,30] Thus, in the face of limited information and uncertainty about disease risk, proactive coping does not mediate perceived stress and coping outcomes. Based on this, this study's hypothesis is that

H4b: The chain mediating role of perceived stress and proactive coping in the relationship between pandemic risk perception and pandemic fatigue is not significant.

In summary, to understand the status of public pandemic fatigue, related factors, and their mechanisms of action, Study 1 first explored the current status of pandemic fatigue from the perspective of public understanding and willingness to cooperate with pandemic prevention policies. Then, Study 2 used a parallel mediation model (Figure 1) based on the stress-response framework and future-oriented coping to discuss the role of pandemic risk perceptions on public pandemic fatigue and the role played by perceived stress and future-oriented coping in it, with a focus on motivation to participate.

Study 1: Status of Public Pandemic Fatigue

WHO considers pandemic fatigue as the lack of motivation of individuals to engage in protective behaviors and seek out pandemic-related information due to unresolved and ongoing adversities in their lives. This study will examine the current state of pandemic fatigue in terms of the public's understanding of and willingness to cooperate with anti-pandemic policies.

Methods

Participants

Using an online questionnaire collection platform, a total of 8426 residents were recruited to complete the questionnaire in Mianyang City, Sichuan Province (Southwest China) over three time periods (13–24 February 2020, 4 February-4 March 2021, and 20 March-27 April 2022, respectively). In the first period (T1: 13–24 February 2020), China was in the midst of a national outbreak and there were multiple diagnosed cases in Mianyang, where residents were isolated at home. In this period, 6007 residents completed the questionnaire, with 5089 participants aged 18–45 years and 918 participants aged 46 years and older. The second period (T2: 13–24 February 2020), when China was in the midst of a localized outbreak, was relatively stable and life in Mianyang was generally normal. In this period, 1448 residents participated in the questionnaire, with an average age of (40.87 ± 10.914) years. In the third period (T3: 20 March - 27 April 2022), the pandemic is more serious in some parts of China (eg Shanghai), but the situation in Mianyang and even in Sichuan Province is relatively good, with only slight inter-provincial transport difficulties. During this period, 971 residents completed the questionnaire, with an average age of (41.02 ± 14.121) years. All participants were over 18 years of age in Mianyang, and all included teachers, doctors, civil servants, and general employees.

Tools

Self-administered questionnaire on the understanding and willingness to cooperate with pandemic prevention policies. The question "Under the current pandemic situation, I can understand and cooperate with pandemic control measures, such as isolation, screening, temperature taking, identity verification, etc." was used to understand residents' participation in pandemic
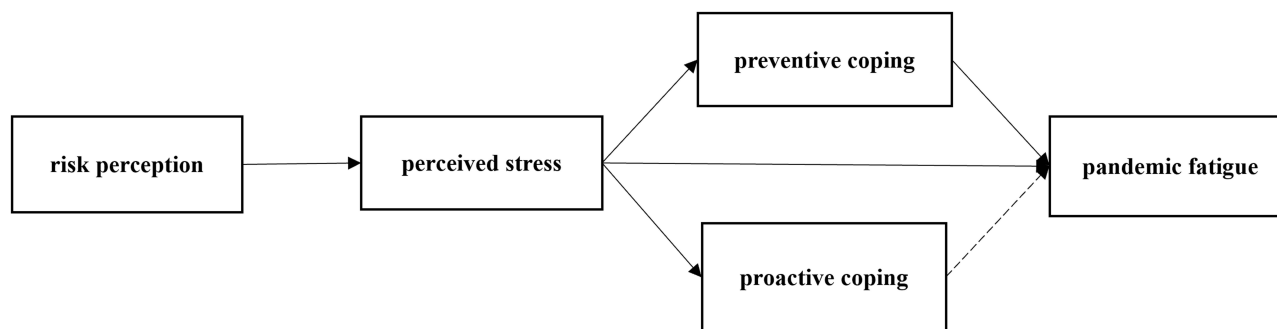

Figure 1 The relationship model diagram.

prevention, control, and management. The question was scored on a 5-point scale, from "not at all" to "completely". The higher the score, the greater the understanding and willingness to cooperate with pandemic prevention policies.

In addition, the study investigated the basic information of the participants, including demographic variables such as age and gender.

Data Analysis

Quantitative data in this study were expressed as means and standard deviations, while qualitative data were expressed as percentages. All data were analyzed using SPSS 25.0. Analysis of variance (ANOVA) was used to understand the three-year difference in the public's understanding of and willingness to cooperate with the pandemic prevention policies. The testing standard was α=0.05.

Results

The results of the ANOVA are shown in Figure 2, with a significant three-year difference in the public's understanding of and willingness to cooperate with the pandemic prevention policy [$F_{(2, 8423)}$ = 13.251, $p < 0.01$, $\eta^2 = 0.003$]. Further post-hoc tests showed that the residents' willingness to understand and cooperate with the pandemic prevention policies was significantly lower in 2022 than in 2020 ($p < 0.01$) and 2021 ($p < 0.01$).

Discussion

Study 1 took the Mianyang region of Sichuan Province as an example to compare the changes in residents' understanding of and willingness to cooperate with pandemic prevention policies over three years, to understand the current state of public pandemic fatigue. The study found that residents' willingness to participate in pandemic prevention and control was significantly lower in 2022 than in 2020 and 2021 and that residents' willingness to participate or cooperate with pandemic prevention and control efforts tended to be negative. This result indicates the existence and increasing level of pandemic fatigue. This is similar to the study by Scandurra et al[20] This implies that over time, there is a tendency for residents to become fatigued by the persistence of COVID-19 and for engagement to become more negative.[38] Therefore, the phenomenon of declining public understanding of and willingness to cooperate with pandemic prevention policies needs to be continuously monitored, and timely targeted interventions should be provided to avoid further deterioration.

Study 2: Predictive Mechanisms of Public Pandemic

Study 1 explores pandemic fatigue in terms of changes in the public's understanding of and willingness to cooperate with pandemic prevention policies. The results found that pandemic fatigue continues to increase in 2022, but the exact causes are not yet known. Therefore, Study 2 proposes to explore the factors associated with pandemic fatigue through the
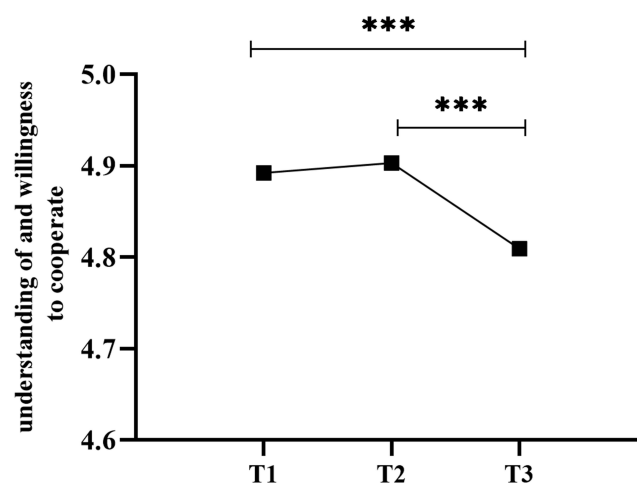

Figure 2 Trends in the public's understanding of and willingness to cooperate with pandemic prevention policies. ***Means $p < 0.001$.

public's activeness of pandemic prevention and control, based on a stress-response framework and a parallel model of future-oriented coping.

Methods

Participants

From 6 April to 27 April 2022, a total of 1986 people were called to participate in a questionnaire in the southwestern regions of China, including Chengdu, Mianyang, and Zigong. During this period, there were no widespread outbreaks in southwest China, but large localized outbreaks occurred in other Chinese provinces, such as Shanghai and Jilin Province. Invalid questionnaires were filtered or followed the following steps: data with response times of less than 300s were removed, similarities were sought (based on IP, submission time, age, place of residence, etc.) to filter duplicates, and Mahalanobis distances were used to exclude data beyond the 0.001 criteria. Finally, 1635 valid data were obtained (82.33%). The minimum age of the participants was 11 years and the maximum age was 77 years, with a mean age of (39.40 ± 11.113) years. Of these, 656 (40.12%) were male with a mean age of (43.42±11.416) years, and 979 (59.88%) were female with a mean age of (36.71±10.048) years.

Tools

Pandemic Risk Perception Scale

COVID-19 Risk Perception Scale was developed by Xi et al[39] The scale consists of nine questions, including "How likely do I think I am to become infected with COVID-19?", "I am worried about contracting the virus" and, "I think I am vulnerable to contracting the virus". The options are scored on a 5- or 6-point Likert scale, with higher scores indicating a higher perceived risk of COVID-19. In this study, Cronbach's alpha coefficient for this scale was 0.863.

Perceived Stress Scale (PSS)

Developed by Cohen et al,[40] it is a 10-item scale (eg "During the past month, how often did you feel out of control of important things in your life?") The higher the score, the greater the perceived level of stress. In this study, Cronbach's alpha coefficient for this scale was 0.788.

Future-Oriented Coping Inventory (FCI)

Revised by Gan et al,[30] it is a 16-item and 5-point scale that includes two subscales: Preventative Coping and Proactive Coping. In this study, Cronbach's alpha coefficient for the Preventive Coping subscale was 0.910 and the Cronbach's alpha coefficient for the Proactive Coping subscale was 0.830.

Questionnaire on the Activeness of Pandemic Prevention and Control (APPC)

A self-administered questionnaire on public participation in pandemic prevention and control was developed concerning a Visual Analogue Scale.[41] The questions were "In the past month, how positive you were about participating in the prevention and control of the pandemic (0–100, 0 being not positive at all, 100 being strongly positive)" and "In the same period last year, how positive you were about the prevention and control of the pandemic (0–100, 0 being not positive at all, 100 being strongly positive)". It means that the higher the score for each question, the more active you are to participate in pandemic prevention and control, and to some extent, it also shows that the higher the score the lower the epidemic fatigue.[6]

Data Analysis

The quantitative data in this study were expressed as means and standard deviations. All data were analyzed using SPSS 25.0. Paired samples *t*-test was used to analyze differences in scores of activeness of pandemic prevention and control between the same period last year and the current period. Pearson's product difference correlation analysis was used to explore the correlations between the variables of risk perception, perceived stress, preventive coping, proactive coping, and APPC. Chain-mediated effects were tested using Model 81 in the SPSS PROCESS macro program written by Hayes.[42]

Results

Test for Common Method Bias

Artificial covariation between predictor variables and validity variables is caused by the same data sources or raters, the same measurement environment, the program context, and the characteristics of the program itself. Such artificial covariation can cause serious confusion about the results of the study and potentially mislead the conclusions and is a form of systematic error, also known as common method biases.[43] The Harman one-way test was used to test for common method bias. It was found that a total of five factors were generated without rotation, with the first factor having an explanatory rate of 29.782%, which is less than the critical criterion of 50%,[43] indicating that there was no significant common method bias in this study.

Trends in Public Participation in Pandemic Prevention and Control

Paired samples t-test was conducted on the scores of the current and the same period last year for the APPC. The results are shown in Figure 3. The scores of the current residents' APPC are significantly lower than those of the same period last year (t= 2.146, $p = 0.032$, r_{pb}^2=0.003).

Results of Descriptive Statistics and Correlation Analysis

The first question of the APPC questionnaire was used to describe the current APPC status, so we used this question as an indicator of the predicted variable. Correlation analyses were conducted on the variables of risk perception, perceived stress, preventive coping, proactive coping, and APPC. As shown in Table 1, perceived stress was significantly and negatively correlated with preventive coping, proactive coping, and APPC ($ps < 0.01$), and risk perception was significantly and negatively correlated with preventive coping, proactive coping, and APPC ($p < 0.01$), preventive coping, proactive coping, and APPC were both significantly and positively correlated ($ps < 0.01$).

Results of the Multiple Chain Mediating Effect Test

Based on the results of the correlation analysis, risk perception as a predictor variable, APPC as an outcome variable, and prevention coping, perceived stress, and proactive coping as mediating variables were tested for chain mediating effects
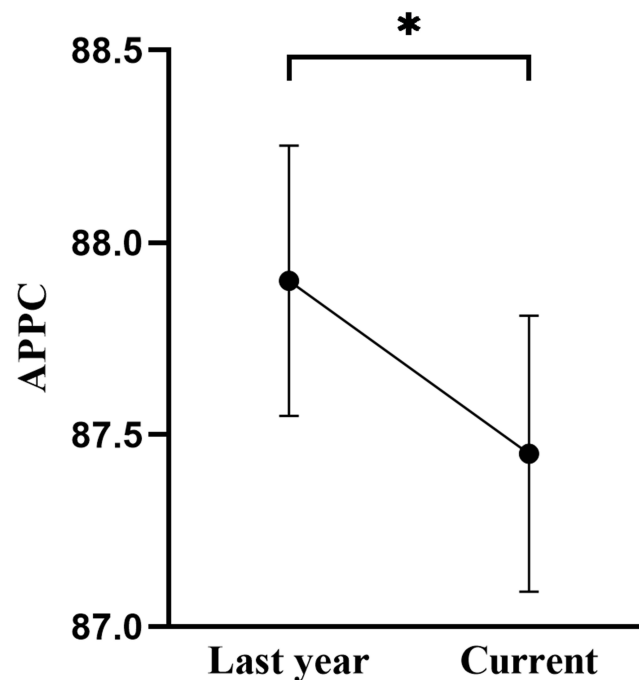

Figure 3 Paired-samples t-test of current versus year-ago scores for APPC. *Means $p < 0.05$.
Abbreviation: APPC, activeness of pandemic prevention and control.

Table 1 Variable Correlation Analysis Table

Variables	M	SD	1	2	3	4	5	6	7
Gender	–	–	1						
Age	39.40	11.113	−0.296**	1					
Risk perception	2.57	0.891	−0.002	0.060*	1				
Perceived stress	2.54	0.603	0.096**	−0.194**	0.282**	1			
Preventive coping	3.59	0.737	−0.091**	0.146**	−0.168**	−0.531**	1		
Proactive coping	3.68	0.647	−0.073**	0.161**	−0.220**	−0.657**	0.811**	1	
APPC	87.45	14.570	−0.077**	0.068**	−0.114**	−0.282**	0.293**	0.299**	1

Note: *Means $p < 0.01$, **Means $p < 0.01$, gender: male = 0, female = 1.
Abbreviations: APPC, activeness of pandemic prevention and control; M, Mean; SD, standard deviation.

using Model 81 in the SPSS PROCESS macro program written by Hayes[42] while controlling for age and gender (Since previous studies have found different responses to pandemics across age and gender populations,[44] and since our correlation analyses found similar results, we included age and gender as covariates to avoid the role of this factor). The results of the regression analysis are shown in Table 2, with risk perception negatively predicting APPC ($b = −0.563$, $t = −1.402$, $95\% CI = [−1.352, 0.225]$) and negatively predicting proactive coping ($b = −0.032$, $t = −2.216$, $95\% CI = [−0.059, −0.004]$), and positively predicting perceived stress ($b = 0.200$, $t = 12.735$, $95\% CI = [0.169,$

Table 2 Regression Analysis of the Relationship Between Variables in the Chained Multiple Mediation Model

Outcome Variables	Predictor Variables	b	SE	p	95% CI	R^2	F
Perceived stress	Gender	0.046	0.030	0.127	[−0.013, 0.104]	0.126	78.635**
	Age	−0.011	0.001	<0.01	[−0.014, −0.008]		
	Risk perception	0.200	0.016	<0.01	[0.169, 0.231]		
Preventive coping	Gender	−0.046	0.033	0.165	[−0.110, 0.019]	0.285	162.290**
	Age	0.003	0.002	0.080	[−0.003, 0.005]		
	Risk perception	−0.022	0.018	0.230	[−0.057, 0.014]		
	Perceived stress	−0.624	0.027	<0.01	[−0.677, −0.570]		
Proactive coping	Gender	−0.002	0.026	0.950	[−0.052, 0.049]	0.434	312.971**
	Age	0.002	0.001	0.047	[0.000, 0.046]		
	Risk perception	−0.032	0.014	0.027	[−0.059, −0.004]		
	Perceived stress	−0.682	0.021	<0.01	[−0.724, −0.640]		
APPC	Gender	−1.336	0.728	0.067	[−2.763, 0.091]	0.111	33.997**
	Age	−0.006	0.033	0.857	[−0.070, 0.058]		
	Risk perception	−0.563	0.402	0.161	[−1.352, 0.225]		
	Perceived stress	−3.431	0.769	<0.01	[−4.939, −1.923]		
	Preventive coping	2.873	0.792	<0.01	[1.319, 4.426]		
	Proactive coping	1.680	1.012	0.097	[−0.305, 3.664]		

Note: **Means $p < 0.01$, gender: male = 0, female = 1.
Abbreviations: APPC, activeness of pandemic prevention and control; b, unstandardized regression coefficient; SE, standard error; p, significance value; 95% CI, 95% confidence interval; R^2, coefficient of determination; F, F-test value.

Table 3 Bootstrap Analysis of the Test of the Mediating Effects

	Effect	Boot SE	Boot LLCI	Boot UICI
Total effect	−1.954	0.401	−2.740	−1.167
Direct effect	−0.563	0.402	−1.352	0.225
Total Indirect Effect	−1.390	0.171	−1.740	−1.077
Path 1	−0.687	0.149	−0.998	−0.410
Path 2	−0.063	0.062	−0.196	0.051
Path 3	−0.053	0.045	−0.159	0.014
Path 4	−0.359	0.104	−0.569	−0.165
Path 5	−0.229	0.146	−0.520	0.057

Notes: Path 1: risk perception - perceived stress - APPC; Path 2: risk perception - preventive coping - APPC; Path 3: risk perception - proactive coping - APPC; Path 4: risk perception - perceived stress - preventive response - APPC; Path 5: risk perception - perceived stress - proactive coping - APPC. **Abbreviations**: APPC, activeness of pandemic prevention and control; Effect, effect value, Boot SE, standard error of the Bootstrap mediation test; Boot LLCI and Boot UICI, lower and upper confidence intervals.

0.231]), supporting that H1 and H2 held. In addition, perceived stress negatively predicted APPC, preventive coping, and proactive coping ($b = −3.431$, $t = 31.953$, 95% $CI = [−4.939, −1.923]$; $b = −0.624$, $t = −22.863$, 95% $CI = [−0.677, −0.570]$; $b = −0.682$, $t = 31.953$, 95% $CI = [−0.724, −0.640]$). Preventive coping positively predicted APPC ($b = 2.873$, $t = 3.638$, 95% $CI = [1.319, 4.426]$).

The Bootstrap mediation test was used to analyze the mediation effect. The results showed (Table 3) that the direct effect of risk perception on the APPC was not significant (95% $CI=[−1.352, 0.225]$). The mediating effect of perceived stress on risk perception and APPC was significant (95% $CI=[−0.998, −0.410]$), accounting for 35.16% of the total effect, and hypothesis H3 was valid. In addition, perceived stress and preventive coping played a chain mediating role in risk perception and APPC (95% $CI=[−0.998, −0.410]$), accounting for 18.37% of the total effect, and hypothesis H4a was held. In contrast, perceived stress and proactive coping did not play a significant role in mediating the chain effect in risk perception and APPC (95% $CI = [−0.520, 0.057]$), and hypothesis H4b was held.

Discussion

The study found that the current residents' participation in the APPC scores was significantly lower than those of the same period last year, validating the results of Study 1. At the same time, the results of Study 2 showed that the perception of pandemic risk negatively predicted public APPC. This suggests that public fatigue is caused by the pandemic as a stressful event. This is similar to the study by Wanberg et al,[13] where risk perception of public emergencies depletes individuals' psychological resources and negatively affects their attitudes and behaviors. Furthermore, the results of Study 2 also suggest that the effect of risk perception on the APPC is through increasing perceived stress, decreasing preventive coping, and thus decreasing their APPC. This suggests that individuals when faced with a pandemic risk stimulus, will make future-oriented coping measures to deal with their potential harm, threat, or challenge by cognitively evaluating the stressor.[9] However, due to the variable fluidity and unpredictability of the pandemic, individuals are unable to take a more proactive approach[29] and can only cope preventively to minimize the damage caused by the stressor.[31]

General Discussion

This paper examines the role played by changes in public pandemic fatigue and risk perceptions through 2 studies. Study 1 investigated the public's understanding of and willingness to cooperate with the pandemic prevention and control policies at three points in time over two consecutive years, and Study 2 asked participants to self-assess changes in their activeness of pandemic prevention and control over two years. Both studies showed a negative trend in public pandemic fatigue. This is in

line with previous studies,[4,20] which suggest that the public has developed a pandemic fatigue response more than two years into the pandemic. Studies have shown that this change in mindset is strongly linked to the persistence of viral risk, ongoing concerns about future life, and ongoing measures to control social distance, nucleic acid testing, or otherwise monitor the pandemic.[6,27] Therefore, this change in public mindset should be fully considered in policy formulation to avoid further worsening of the negative mindset.

To further explore the predictors of pandemic fatigue, Study 2 used public participation in pandemic prevention and control as the dependent variable based on a stress-response perspective and found that pandemic risk perception negatively predicted APPC, ie, when risk perception was higher, individual pandemic fatigue was higher. This is similar to the study by Bodas and Peleg (2021),[18] where the risk of infection posed by COVID-19, as a stressor, would lead individuals to react in a way that is appropriate to the environment they are in. Moreover, risk events place a heavy psychological load on individuals in stressful situations, and when the load is overloaded, emotional, or cognitive behaviors such as depression and the development of burnout are manifested,[17] and pandemic fatigue is typical of the public under persistent pandemic risk.

In addition, we explored the mechanisms by which risk perception predicted pandemic fatigue. First, we found that risk perception does not directly predict pandemic fatigue, but is mediated through perceived stress, ie risk perception increases pandemic fatigue by increasing the population's perceived stress and, in turn, pandemic fatigue. Previous research has found that stress is significantly felt when individuals perform work or tasks in unpredictable and uncontrollable risk situations.[22] Therefore, when individuals perceive risk, perceived stress rises with it. Moreover, according to the theory of the JD-R, the depletion process is automatically initiated by the individual's perceived stress, and burnout occurs under sustained stress.[23] Our results on pandemic fatigue confirm this theoretical process, ie individuals who are at constant and uncertain risk have higher perceived stress, and higher and constant stress leads to individual fatigue, making individuals less motivated and less willing to participate in various health protection behaviors. At present, government agencies and social organizations need to pay attention to the pathways and contents of public risk perceptions, insist on truthfulness and transparency in information related to the pandemic, avoid over-sensitivity and alertness or over-ignorance of public risk perceptions, and achieve prevention and control of pandemic fatigue.

Secondly, it is worth noting that Study 2 also explored the role of proactive and preventive coping in the mediation model of "risk perception → perceived stress → pandemic fatigue" based on the stress-response framework and the parallel mediation model of future-oriented coping. The current results show that perceived stress and proactive coping significantly mediate the chain in the relationship between risk perception and pandemic fatigue; however, perceived stress and proactive coping do not significantly mediate the chain in the relationship between risk perception and pandemic fatigue. Lazarus' cognitive interaction theory suggests that, in addition to cognitive appraisal, coping is an important mediating variable in the process by which stressors cause individuals to produce stress-related responses. It is the cognitive and behavioral effort that individuals choose to make based on their resources after assessing the stressor.[8] According to parallel models of future-oriented coping, both proactive and preventive coping mediate the relationship between perceived stress and coping outcomes.[30,32] However, proactive coping focuses on threatening stressors that are relatively distant and have a high degree of uncertainty, and individuals respond in advance to minimize the damage caused by the stressor.[31] Proactive coping, on the other hand, focuses on challenging stressors, where individuals respond in advance to promote self-improvement and growth.[29,31,36] However, given the current international situation, the future outlook for pandemic control remains uncertain. For individuals, the only way to minimize the damage caused by the pandemic is to respond in advance.[31] Therefore, of the two dimensions of future-oriented coping, only preventive coping serves as an intermediate variable in the process of risk perception, and perceived stress for pandemic fatigue prediction. This means that the path of proactive coping does not eliminate pandemic fatigue and that only by increasing the means of preventive coping can effective prevention of pandemic fatigue be achieved.

Based on a stress-response framework and a parallel model of future-oriented coping, this paper illustrates, to some extent, the predictive mechanisms of declining public participation in pandemic prevention and control through 2 studies. This provides a reference for the formulation of global pandemic prevention and control policies, as well as a direction to focus on the identification of public social mindset and response to persistent pandemic risk. However, this study is still a cross-sectional study and can only discuss the relationship between variables, not the cause and effect between them.

Follow-up studies can be conducted using a longitudinal design to provide more favorable evidence to reveal the causal relationship between the two. In addition, the results of this study on the public's APPC were derived from public opinion surveys and not actual compliance rates. There may be a social desirability bias in which people may fill out questionnaires with attitudes that deviate from reality.[45,46] A study found that compliance with strict behavioral norms remained very high (over 90%) although many people were affected financially and psychologically.[47] Although we emphasized in our survey that there is no right or wrong result,[45] the result is still not accurate enough. Therefore, when considering pandemic fatigue, it is important to also include actual compliance rates and further explore the mechanisms by which pandemic fatigue occurs and works, and how to respond.

Conclusion

Public pandemic fatigue is on the rise today. Pandemic fatigue can be predicted by the public's risk perception, but it cannot be predicted directly and requires the mediation of perceived stress and preventive coping. The mechanism is that risk perception increases perceived stress, which in turn acts on pandemic fatigue through preventive coping rather than proactive coping. The analysis of pandemic fatigue prediction mechanisms can provide a more efficient tool for future public health management.

Data Sharing Statement

The data that support the findings of this study are available from the corresponding author Changxia Chen, upon reasonable request.

Ethics Approval and Consent to Participate

This study was conducted in strict accordance with the Declaration of Helsinki and received ethical approval from the Institutional Committee of Law School, Southwest University of Science and Technology in Mianyang, China (No. LL23001). Informed consent was signed by each adult participant, or their parent(s) or legal guardian(s) on behalf of adolescent participants.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis, and interpretation, or all these areas; took part in drafting, revising, or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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References

1. Glatter KA, Finkelman P. History of the plague: an ancient pandemic for the age of COVID-19. *Am J Med*. 2021;134(2):176–181. doi:10.1016/j.amjmed.2020.08.019
2. Jørgensen FA-OX, Bor AA-O, Rasmussen MS, Lindholt MF, Petersen MA-O. Pandemic fatigue fueled political discontent during the COVID-19 pandemic. *Proc Natl Acad Sci USA*. 2022;119(48):e2201266119. doi:10.1073/pnas.2201266119
3. Labrague LA-O. Pandemic fatigue and clinical nurses' mental health, sleep quality, and job contentment during the covid-19 pandemic: the mediating role of resilience. *J Nurs Manag*. 2021;29(7):1992–2001. doi:10.1111/jonm.13383
4. Masten AS, Motti-Stefanidi F. Multisystem resilience for children and youth in disaster: reflections in the context of COVID-19. *Advers Resil Sci*. 2020;1(2):95–106. doi:10.1007/s42844-020-00010-w
5. Petherick AA-O, Goldszmidt RA-O, Andrade EA-O, et al. A worldwide assessment of changes in adherence to COVID-19 protective behaviours and hypothesized pandemic fatigue. *Nat Hum Behav*. 2021;5(9):1145–1160. doi:10.1038/s41562-021-01181-x

6. Teixeira da Silva JA. Corona exhaustion (CORONEX): COVID-19-induced exhaustion grinding down humanity. *Cur Res Behav Sci*. 2021;2:100014. doi:10.1016/j.crbeha.2021.100014

7. AaB A-T, Tarhini Z, Akour A. A swaying between successive pandemic waves and pandemic fatigue: where does Jordan stand? *Ann Med Surg*. 2021;65:102298. doi:10.1016/j.amsu.2021.102298

8. Lazarus RS. Coping theory and research: past, present, and future. *Psychosom Med*. 1993;55(3):234–247. doi:10.1097/00006842-199305000-00002

9. Lazarus RS. From psychological stress to the emotions: a history of changing outlooks. *Annu Rev Psychol*. 1993;44:1–21. doi:10.1146/annurev.ps.44.020193.000245

10. Vaughn-Coaxum RA, Wang Y, Kiely J, Weisz JR, Dunn EC. Associations between trauma type, timing, and accumulation on current coping behaviors in adolescents: results from a large, population-based sample. *J Youth Adolesc*. 2018;47(4):842–858. doi:10.1007/s10964-017-0693-5

11. Brown SM, Doom JR, Lechuga-Peña S, Watamura SE, Koppels T. Stress and parenting during the global COVID-19 pandemic. *Child Abuse Negl*. 2020;110:104699. doi:10.1016/j.chiabu.2020.104699

12. Taylor S. COVID stress syndrome: clinical and nosological considerations. *Current Psychiatry Rep*. 2021;23(4):19. doi:10.1007/s11920-021-01226-y

13. Wanberg CA-O, Csillag BA-O, Douglass RA-O, Zhou LA-O, Pollard MA-OX. Socioeconomic status and well-being during COVID-19: a resource-based examination. *J Appl Psychol*. 2020;105(12):1382–1396. doi:10.1037/apl0000831

14. Joffe H. Risk: from perception to social representation. *Br J Soc Psychol*. 2003;42(1):55–73. doi:10.1348/014466603763276126

15. Siegrist M, Gutscher H, Earle TC. Perception of risk: the influence of general trust, and general confidence. *J Risk Res*. 2005;8(2):145–156. doi:10.1080/1366987032000105315

16. Fredrickson BL, Tugade MM, Waugh CE, Larkin GR. What good are positive emotions in crises? A prospective study of resilience and emotions following the terrorist attacks on the United States on September 11th, 2001. *J Pers Soc Psychol*. 2003;84(2):365–376. doi:10.1037//0022-3514.84.2.365

17. Mitchell MS, Greenbaum RL, Vogel RM, Mawritz MB, Keating DJ. Can you handle the pressure? The effect of performance pressure on stress appraisals, self-regulation, and behavior. *Acad Manage J*. 2019;62(2):531–552. doi:10.5465/amj.2016.0646

18. Bodas M, Peleg K. Pandemic fatigue: the effects of the COVID-19 crisis on public trust and compliance with regulations in Israel. *Health Aff*. 2021;40(8):1225–1233. doi:10.1377/hlthaff.2021.00171

19. Queen D, Harding K. Societal pandemic burnout: a COVID legacy. *Int Wound J*. 2020;17(4):873–874. doi:10.1111/iwj.13441

20. Scandurra C, Bochicchio V, Dolce P, Valerio P, Muzii B, Maldonato NM. Why people were less compliant with public health regulations during the second wave of the Covid-19 outbreak: the role of trust in governmental organizations, future anxiety, fatigue, and Covid-19 risk perception. *Curr Psychol*. 2021;42:7403–7413. doi:10.1007/s12144-021-02059-x

21. von Helversen B, Rieskamp J. Stress-related changes in financial risk taking: considering joint effects of cortisol and affect. *Psychophysiology*. 2020;57(8):e13560. doi:10.1111/psyp.13560

22. Peters A, McEwen BS, Friston K. Uncertainty and stress: why it causes diseases and how it is mastered by the brain. *Prog Neurobiol*. 2017;156:164–188. doi:10.1016/j.pneurobio.2017.05.004

23. Pines AM, Keinan G. Stress and burnout: the significant difference. *Pers Individ Dif*. 2005;39(3):625–635. doi:10.1016/j.paid.2005.02.009

24. Dima G, Meseşan Schmitz L, Şimon M-C. Job stress and burnout among social workers in the VUCA world of COVID-19 pandemic. *Sustainability*. 2021;13(13):7109. doi:10.3390/su13137109

25. Nitschke JP, Forbes PAG, Ali N, et al. Resilience during uncertainty? Greater social connectedness during COVID-19 lockdown is associated with reduced distress and fatigue. *Br J Health Psychol*. 2021;26(2):553–569. doi:10.1111/bjhp.12485

26. Langerak J, Koen J, Van Hooft EAJ. How to minimize job insecurity during the COVID-19 pandemic. *Acad Manag Proce*. 2021;2021(1):11607. doi:10.5465/AMBPP.2021.69

27. Su Z, McDonnell D, Ahmad J, Cheshmehzangi A, Xiang Y-T. Mind the "worry fatigue" amid Omicron scares. *Brain Behav Immun*. 2022;101:60–61. doi:10.1016/j.bbi.2021.12.023

28. Jin S, Zheng L, Wen J, Miao M. The relationship between active coping and hope during the COVID-19 pandemic: the mediating role of meaning in life. *J Health Psychol*. 2021;13591053211062347. doi:10.1177/13591053211062347

29. Miao M, Gan Y. The promotional role of meaning in life in future-oriented coping: positive affect as a mediator. *J Health Psychol*. 2020;55(1):52–59. doi:10.1002/ijop.12543

30. Gan Y, Yang M, Zhou Y, Zhang Y. The two-factor structure of future-oriented coping and its mediating role in student engagement. *Pers Individ Dif*. 2007;43(4):851–863. doi:10.1016/j.paid.2007.02.009

31. Schwarzer R, Taubert S. Tenacious goal pursuits and striving toward personal growth: proactive coping. In: *Beyond Coping: Meeting Goals, Visions, and Challenges*. Oxford University Press; 2002:19–35.

32. Gan Y, Zheng W, Wen Y. The sequential model of future-oriented coping and adjustment to university life: the role of attitudes as further evidence. *Psychol Rec*. 2014;64(1):13–20. doi:10.1007/s40732-014-0024-0

33. Hu Y, Gan Y. Future-oriented coping and job hunting among college students. *Psychol Rec*. 2011;61(2):253–268. doi:10.1007/BF03395759

34. Sohl SJ, Moyer A. Refining the conceptualization of a future-oriented self-regulatory behavior: proactive coping. *Pers Individ Dif*. 2009;47(2):139–144. doi:10.1016/j.paid.2009.02.013

35. Luszczynska A, Szczuka Z, Abraham C, et al. The interplay between strictness of policies and individuals' self-regulatory efforts: associations with handwashing during the COVID-19 pandemic. *Ann Behav Med*. 2022;56(4):368–380. doi:10.1093/abm/kaab102

36. Aspinwall LG, Taylor SE. A stitch in time: self-regulation and proactive coping. *Psychol Bull*. 1997;121(3):417–436. doi:10.1037/0033-2909.121.3.417

37. Chang Y, Chien C, Shen L-F. Telecommuting during the coronavirus pandemic: future time orientation as a mediator between proactive coping and perceived work productivity in two cultural samples. *Pers Individ Dif*. 2021;171:110508. doi:10.1016/j.paid.2020.110508

38. World Health Organization. Pandemic fatigue: reinvigorating the public to prevent COVID-19: policy considerations for member states in the WHO European region; 2020. Available from: https://apps.who.int/iris/handle/10665/335820. Accessed September 11, 2023.

39. Ju-zhe X, She Z, Ju K, et al. Development and validation of the new coronary pneumonia epidemic risk perception scale. *J Capit Norm Univ*. 2020;(4):131–141.

40. Cohen S. Perceived stress in a probability sample of the United States. In: *The Social Psychology of Health*. Sage Publications, Inc; 1988:31–67.

41. Klimek L, Bergmann K-C, Biedermann T, et al. Visual analogue scales (VAS): measuring instruments for the documentation of symptoms and therapy monitoring in cases of allergic rhinitis in everyday health care. *Allergo J Int*. 2017;26(1):16–24. doi:10.1007/s40629-016-0006-7

42. Hayes AF. *Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based Approach*. Guilford publications; 2017.

43. Malhotra NK, Kim SS, Patil A. Common method variance in IS research: a comparison of alternative approaches and a reanalysis of past research. *Manage Sci*. 2006;52(12):1865–1883. doi:10.1287/mnsc.1060.0597

44. Daoust JF. Elderly people and responses to COVID-19 in 27 countries. *PLoS One*. 2020;15(7):e0235590. doi:10.1371/journal.pone.0235590

45. Daoust JF, Bélanger É, Dassonneville R, et al. A guilt-free strategy increases self-reported non-compliance with COVID-19 preventive measures: experimental evidence from 12 countries. *PLoS One*. 2021;16(4):e0249914. doi:10.1371/journal.pone.0249914

46. Daoust JF, Nadeau R, Dassonneville R, et al. How to survey citizens' compliance with COVID-19 public health measures: evidence from three survey experiments. *J Exp Political Sci*. 2021;8(3):310–317. doi:10.1017/XPS.2020.25

47. Reicher S, Drury J. Pandemic fatigue? How adherence to covid-19 regulations has been misrepresented and why it matters. *BMJ*. 2021;372:n137. doi:10.1136/bmj.n137