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ARTICLE

Serial Multiple Mediation of the Relationship between Positive Coping Style and Post-Traumatic Growth among Chinese College Students in the Aftermath of COVID-19

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ABSTRACT

Given the ongoing character of COVID-19, higher-education students encountered multifaceted pressures brought about by the pandemic and had to overcome many difficulties during this period. Accordingly, it is imperative to identify the factors that may have protective effects on the social functioning and mental status of college students in the aftermath of COVID-19. This cross-sectional study sought to ascertain the internal mechanism of positive coping (PC) styles affecting post-traumatic growth (PTG) and considered the mediating roles of cognitive reappraisal (CR), psychological resilience (PR), and deliberate rumination (DR), which are essential for understanding how and to what extent these factors shaped PTG in the context of the present pandemic. 463 Chinese college students recruited via a convenience sampling method completed a set of online self-report measures of PC, PTG, CR, PR and DR. The findings revealed that the abovementioned five variables were positively correlated with each other, and the independent variable directly predicted the dependent variable. More importantly, two out of three mediators in parallel mediated the relationship between PC and PTG, illustrating that more PC adoption was associated with increased PTG through high levels of PR and DR, respectively. The two significant serial mediating effects also indicated that PC could contribute to CR, which further facilitates either PR or DR and subsequently promotes the development of PTG. Colleges should adopt routine protective behaviors in accordance with such evidence to strengthen students' mental health education and establish scientific methods to boost their psychological well-being. Overall, our results may shed new light on the process of positive adaption and provide theoretical support for targeted crisis intervention during the late phase of the pandemic.

KEYWORDS

Coping style; post-traumatic growth; psychological resilience; cognitive reappraisal; deliberate rumination

Introduction

The COVID-19 is an infectious respiratory disease characterized by a high fatality rate [1]. As this pandemic spread exponentially, governments and public healthcare agencies issued nationwide movement restrictions and quarantines (large-scale lockdowns, travel bans, and self-isolation) as emergency measures to contain viral transmission [2,3]. Both the sudden outburst of contagion and extraordinary preventive policies have had a profound and wide range of psychosocial influences [4–6]. Hence, experts from diverse disciplines have increasingly emphasized the urgency and significance of assessing social function and mental health status during the COVID-19 pandemic.

Chinese students in higher education experienced a multifaceted crisis during this period. In addition to the transformation of byg one lifestyle, academic workload, economic burden, employment pressures, and relationship concerns were further amplified by the pandemic [7]. These

stressful experiences put college and university students at risk of psychological struggles [8,9]. Negative experiences, however, can also be regarded as "catalysts" for positive change. Recovery from trauma should be more consequential than initial distress *per se*, particularly when adversity involves extensive disruptions over an extended period [10]. Considering that COVID-19 has now transitioned from its explosive growth stage to a normal containment stage in China [11,12], it is imperative to inquire whether and how Chinese college students grow through such challenges and to identify protective factors against the mental health problems brought about by COVID-19. Such investigations would enrich the knowledge on how individuals maintain mental wellness in the wake of these highly stressful life events during the late phase of the pandemic.

Theoretical Backgrounds and Research Hypothesis

According to the organismic valuing theory, traumatic incidents often result in maladaptation. This has the effect of forcing new information involving the trauma to be merged with existing approach and creating a new perspective of the world [13]. Consequently, these invasive and distressing initial experiences and psychological variables come together to produce a constructive process. Post-traumatic growth (PTG), coined first by Tedeschi and Calhoun in 1996, is one of the most broadly discussed salutogenic post-traumatic consequences. This term refers to the positive, meaningful psychological changes experienced as a result of the struggle with highly challenging life circumstances [14]. Typically, the manifestation of PTG involves more positive interpersonal relationships, a deeper existential and spiritual life, an increased attitude toward taking new chances in life, redefining priorities, a greater sense of personal strength, and an enhanced appreciation of life [15]. Instead of being a direct result of a distressing experience, the process of PTG formation is related to an individual's cognitive reconstruction leading to the adaptation of a new reality, which frequently occurs after coping and struggling with the experience of a traumatic event [14]. According to PTG, experiencing traumatic events that upend a person's life might inspire them to adopt new beneficial beliefs. PTG is made up of three primary components: (1) a sense of personal empowerment and resiliency; (2) a shift in how one feels about others, such as the ability to tolerate opposing viewpoints and a rise in sympathy and compassion; and (3) a sense of a change in life philosophy, which includes a shift in goals and values, a greater reverence for life, and an improved comprehension of one's own spirituality and existential issues [16,17]. Aspects related to traumatic events, such as positive coping (PC) strategies (e.g., positive reappraisal), sharing negative emotions, cognitive processing or rumination, and resilience have been confirmed to promote the emergence of PTG [18]. Regarding COVID-19, a wide range of investigations have already recognized the opportunities for powerful growth that come from hardships [19–21]. Nonetheless, little attention has focused on the antecedent factors and underlying psychological mechanisms potentially contributing to PTG in the context of the present pandemic.

Although there is no specific formula for managing life to improve well-being, as Tedeschi and Calhoun noted, a person's coping style is possibly connected to their growth process. Coping style has been defined as a set of adaptive or maladaptive cognitive/behavioral attempts used to manage, endure, reduce, or limit the level of stressful encounters to deal with personal and social challenges [22]. Generally, coping styles are classified into PC and negative coping styles [23]. The former is beneficial for alleviating the impact of stressful situations and maintaining mental health, whereas the latter plays an opposing role [24]. When faced with stress, individuals with PC strategies have positive thoughts and solutions (e.g., constructive actions), such as seeking social support or advice (from friends, peers, family and even the community), acceptance and positive reframing, and problem solving [25]. PC have long been seen as a crucial personal resource for efficiently alleviating the negative effects of stress and its attendant harmful repercussions, which help maintain both physical and mental health. A burgeoning body of literature has shown that the utilization of PC mechanisms is protective against poor mental health outcomes [26,27] and perceived traumatic stress brought on by the COVID-19 [28]. Moreover, reinforcement of PC strategies through coping skills trainings was seen as beneficial for boosting the psychological well-being of healthcare personnel throughout the pandemic [29]. The improved PC applications could foster a more positive perception of potentially threatening situations, strengthen one's capacity to acclimatize, and help individuals give meaning to experienced events, which may play a major role in the implementation of successful adaptation. In this case, the enhancement of PTG after trauma lies not in avoiding stress but in how people adopt positive solving means to handle it. Indeed, previous investigations have further shown that a combination of adaptive coping strategies is related to PTG [30,31], indicating that some early success in coping was thought to be a precursor to later PTG. Examining the role of PC in PTG may elucidate the regulatory mechanisms that facilitate constructive recovery from trauma—a goal the present study begins to address. Therefore, we propose the following hypothesis:

Hypothesis 1: PC is positively correlated with PTG

In line with the information related to the literature, coping is increasingly recognized as a necessary antecedent factor in the development of PTG and does not lead to PTG directly [32]. The "pathway" and "outcomes" of PC should be adequately understood in the context of the COVID-19 aftermath. According to the functional descriptive model of PTG [14], an essential element of the PTG process is the management of distressing emotions evoked by traumatic events, which may be produced by the adoption of adequate coping strategies [33].

Emotion regulation (ER) is a cognitive-behavioral process whereby individuals consciously and/or non-consciously adjust their internal affective states (e.g., magnitude, duration, and expression) to meet

environmental demands appropriately, thereby generating adaptive responses [34]. Controlling efforts and the capacity for self-guide without consideration of incentives or encouragement are necessary for ER. To alter or sustain emotional state, ER includes a variety of cognitive and an attentional processes. John and Gross [35] categorized ER strategies into cognitive reappraisal (CR) and expressive suppression (ES). CR is a form of cognitive change by which individuals alter their focus from the negative aspects of trauma to the positive aspects. This process is an antecedent-focused strategy to induce ER through subjective attempts to reinterpret the plot, which happens at the preceding stage of emotion generation. On the contrary, as a response-focused strategy that takes place towards the end of the emotion-generating process, ES is mostly manifested in the conduct of the person who suppresses the expression of emotion to regulate emotion consciously [36]. Considering that these two commonly used ER strategies represent fundamentally distinct disengagement and engagement routes for managing distressing emotions, recent ER and PTG research suggests that only the CR regulatory preference profile has important functions in terms of enhancing individuals' positivity levels and has downstream effects on trauma recovery [37,38]. The theoretical model of PTG proposes that as individuals reintegrate their disrupted core beliefs, they attempt to regulate their emotions in a way that facilitates constructive thinking and allows them to willingly engage with trauma-related memories and emotions [14]. To date, the nature of the possible relationship between the habitual use of PC and CR strategies has not yet been clearly established, while far less attention has been paid to the potential mediating role of CR between PC and PTG. Therefore, we propose the following hypothesis:

Hypothesis 2: CR mediates the relationship between PC and PTG

Another proximal factor that strongly affects the psychological growth outcomes of trauma-exposed individuals is psychological resilience (PR)—a process of good adaptation in the face of adversity; trauma; tragedy; threats; or other potentially negative repercussions of stressors such as family and relationship problems, serious health problems, and financial problems [39]. Generally, PR refers to a context-dependent "reconfiguration" after trauma exposure, which represents a multi-dimensional human ability to quickly return to pre-crisis status [40] and demonstrate improved physical fitness, reaction and coping skills despite going through traumatic events [41]. From a behavioral perspective, PR can be defined as a stable trajectory of healthy functioning following adverse events [42]. Similarly, it can also be viewed as a dynamic mechanism that mobilizes internal and external resources to strengthen the capacity to withstand setbacks and bounce back from adversity [43]. As proposed by the Rutter Model of Development, mental resilience functions via mitigating the devastating impact of risk factors, relieving collateral reactions to hazards in the environment, fostering self-esteem and self-efficacy, and offering opportunities and resources for individuals [44,45].

Within the limited literature on the resources that may contribute to combating the detrimental consequences and improving positive personal progress during the COVID-19 aftermath, coping strategies and PR are undoubtedly among the most studied [46]. Coping and resilience overlap but have different constructs concerning their effects on behavioral changes. The former refers to cognitive and behavioral strategies to handle the negative psychological outcomes arising from adversity [22], whereas the latter refers to the reduction of vulnerability to challenges and difficulties [47] and the improvement of adaptive capacity to recover [48]. Accordingly, utilizing effective coping strategies such as positive reinterpretation appears to be a means of resilience-building intervention. Such interventions could provide possibilities for developing adaptive responses with appropriate scaffolding and guidance, which is integral to realizing one's growth [49]. Considering the recent focus of resilience research, some studies have observed beneficial relationships between PR and PTG [50,51]; however, the mediating effects of college students' PR on the relationship between PC and PTG have not been thoroughly revealed. Based on previous findings, it can be inferred that PC is indirectly associated with PTG through PR. Thus, we propose the following hypothesis:

Hypothesis 3: PR mediates the relationship between PC and PTG

Evidence also seems to be mounting regarding the association of ER and PR, which concluded that a high-level ER is positively related to PR, and the abovementioned discrete ER strategies (CR and ES) are likewise related to PR [52,53]. In particular, the positive correlation between CR and PR has been supported in several studies, even after controlling for other explanatory variables [54–57]. CR is regarded as an adaptive strategy of positively reinterpreting a stressor to mitigate or resist its emotional impact [58], which may further facilitate accommodative psychosocial processes and redefine the meaning of experiences after stressful situations. Even so, there remains a dearth of in-depth studies on the serial mediating mechanism of "PC-PTG" concerning the essential roles of CR and PR. Therefore, we formulated the following hypothesis:

Hypothesis 4: CR and PR play a serial mediating role between PC and PTG

The cognitive process of attempting to reconcile conflicting assessments of a traumatic experience and fundamental beliefs is known as rumination, which is a steady, ongoing, recurrent metacognitive process [45]. According to the Response Styles Theory, rumination was originally conceptualized as a way of reacting to distress and is characterized by repetitive and passive thought about the cause and consequences, and significance of distress and related clues [59]. This notion may be comparable to the rearrangement of values and priorities to find a positive meaning in stressful events, and attempts to integrate the experiences into life narrative. Typically, rumination can be classified into two main types: intrusive rumination (IR) and deliberate rumination (DR) [60]. Each has been assigned a different role in the PTG process. Automatic IR is

predominant and affects the persistence of tension and stress in the initial stage of post-traumatic re-adaptation [60]. For many people, IR is gradually replaced by a more reflective and controlled DR with time. DR is conceptualized as repetitive cognitive engagement that motivates individuals to have purposeful thoughts, consciously thinking about the traumatic experience and even about solutions and consequences—what happened and what it can mean [32]. As a kind of adaptive type of rumination, DR about events is engaged in voluntarily and consists of more intentional and controlled consideration focusing on making sense of the experience, problem-solving, reminiscence and anticipation even in the midst of the uncertainty [61]. Thus, the DR process arises from efforts to incorporate individuals' traumatic experiences into their own cognitive model and reconstruct their understanding of themselves to a greater extent, which may trigger personal growth thereafter [62]. With this in mind, the intensity and persistence of DR have been witnessed as crucial determinants of PTG; that is, the more rumination participants tended to report experiencing soon after the event, the greater the degree of PTG [63,64]. Furthermore, coping is theoretically embedded between IR and DR [65,66]. The active utilization of self-sufficient coping strategies, such as positive reinterpretation, seems to be conducive to more positive cognitive engagement and behavioral adjustments, which may pave the way for fostering PTG. Thus, we can distill from the above evidence that DR generally acts as a mediator between PC and PTG, and propose the following hypothesis:

Hypothesis 5: DR mediates the relationship between PC and PTG

Considering the abovementioned classification, CR is an antecedent-focused strategy in which individuals reframe their belief of a situation with the objective of modifying its emotional influence [67]. The successful CR of negative experiences may help individuals apply psychological leverage to adapt to [68,69] and alleviate the harmful effects of stress on maladaptive consequences [70]. Previous research has proposed that rumination accounts for the relationship between multiple aspects of ER difficulties and post-traumatic stress disorder severity [71]. In this case, with a view to the positive psychological factors associated with recovery, it is possible that DR may also be a critical cognitive process linking specific aspects of ER to PTG. In addition to Hypothesis 5, the following hypothesis is proposed:

Hypothesis 6: CR and DR play a serial mediating role between PC and PTG

By verifying the variables that prompt the development of PTG within the context of the COVID-19 aftermath, public health efforts may be tailored accordingly to constructively foster positive psychological changes among college students. Although previous studies have focused on either the bivariate relationships between PC, ER, PR, and DR, or whether these processes alone are associated with or predict PTG, an integrated framework that includes multiple constructs can provide a platform to better depict broad research and theoretical synthesis. To fill this gap, the foremost initiative of this study was to explore the interconnections between the abovementioned factors and the mediating roles of CR, PR, and DR specifically and serially in the relationship between PC and PTG. According to a thorough review of the existing literature, the current study is the first to address these five concepts holistically, providing in-depth insight into the positive mechanisms underlying college students' PTG in light of the COVID-19 pandemic. Fig. 1 shows a diagram of the mediation model proposed for the six hypotheses, which depicts the relationships between the independent (PC), mediator (ER, PR and DR), and dependent (PTG) variables.

Materials and Methods

Participants and data collection procedure

The studies involving human participants were reviewed and approved by the Ethics Committee of Liaoning Normal

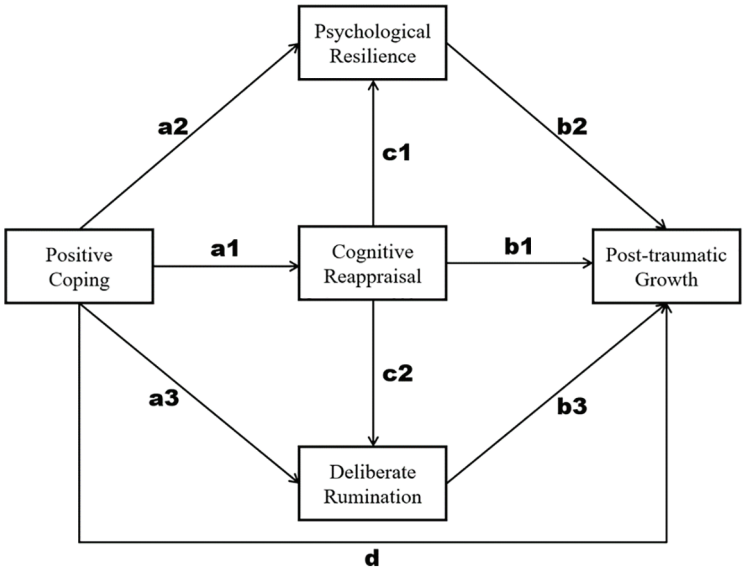

FIGURE 1. Proposed research model.

University (No. LL2023005) on May 01, 2021. A non-probability convenience sampling method was used to recruit participants between May 18 and July 22, 2021. This kind of sampling means that researchers choose the sample as opposed to randomly selecting, which is commonly used in the field of mental health during COVID-19 [72–74]. It allows researchers to generate large samples in short time periods and requires minimal cost. Restricted by isolation policy and movement restrictions, the questionnaire hyperlink was sent to familiar teachers from several universities in mainland China via WeChat and email. The online survey was carried out with the assistance of course teachers by distributing an electronic QR code from the *Wenjuanxing* platform to full-time undergraduate students before or after their class. The questionnaire can only be submitted after all the items have been completed. Given that the participants were recruited by their teachers and the data was obtained through student self-reports, the socially desirable response bias should be carefully considered. With this in mind, all participants remained anonymous and voluntary. They were informed of the academic purpose of this scientific investigation prior to data collection, and their personal information was kept confidential to protect privacy during the study process. They were also told that their responses were neither good nor bad and unrelated to their academic performance or personal impression.

The present survey started with sociodemographic details of the participants, including sex, grade, major (medical, non-medical), residence, and only-child status. Further questions about their COVID-19 awareness were conducted through "*How much do you care about your physical/mental health during this outbreak?*", "*Recognition of the effectiveness of pandemic prevention and control measures in China*" and "*Assessment of the future pandemic situation in China*", based on a self-assessment 5-point Likert scale ranging from 1 (*none*) to 5 (*very significant*). Thereafter, participants were asked to complete a battery of psychological assessments. The psychometric instruments (CR, PR, DR, PTG, and PC) were developed using standard methods of translation, test, revision, and back-translation and were applicable to the Chinese group. All these scales were administered in the stated order. The progress bar provides an overview of the percentage of completed questions. The questionnaire was submitted only after completing all the items. Otherwise, the assessment system automatically recorded the data as null data. To ensure participants' involvement, attention-stability-test items were intermittently inserted into the questions. Questionnaires completed in less than four minutes (decided by the pretest) were deemed invalid and deleted. The final sample comprised 463 students, predominantly females (n = 365; 78.83%). Most of the respondents were from 2nd and 3rd grade (78.2%).

Psychometric instruments

Post-traumatic growth inventory

The original Post-Traumatic Growth Inventory (PTGI) was developed by Tedeschi and Calhoun to measure the positive experiences of individuals who have gone through traumatic events [75]. The translated Chinese version [76] used here has demonstrated adequate psychometric properties and been adapted to suit the specific COVID-19 epidemic context. A total of 21 items are divided into five dimensions, namely, spiritual change, appreciation of life, personal strength (four items), new possibilities and relationships with others. Each item is answered based on a 6-point Likert scale ranging from 0 (*no change*) to 5 (*complete change*). The lowest gross score that can be obtained from summing all items is 0, and the highest gross score is 105. A higher score represents additional positive psychological changes in the trauma aftermath. Within the scope of the research, the internal consistency reliability of the employed scale was recalculated (Cronbach's alpha = 0.96 & McDonald's Omega = 0.96).

Simplified coping style questionnaire

The Chinese version of the Simplified Coping Style Questionnaire (SCSQ) was developed by Xie to measure attitudes and coping manners of specific life events or difficulties encountered during daily lives [23]. The 20-item scale encompasses two dimensions: the first 12 items cover positive coping styles (e.g., "*to be free from work, study, or some other activities*") and the latter 8 items cover negative coping styles (e.g., "*relieve trouble by smoking, drinking, taking medicine, and holding things*"). Each item is scored on a 4-point Likert scale ranging from 0 (*never*) to 3 points (*very often*). The minimum and maximum points are 0 and 60 points, respectively. The higher the dimension score, the more habitual utilization of the corresponding coping style by individuals with stress. Regarding the hypotheses, only positive coping styles were adopted in the mediation model. Within the scope of the research, the internal consistency reliability of the employed scale was recalculated (Cronbach's alpha = 0.85 & McDonald's Omega = 0.85).

Emotion regulation questionnaire

The Chinese version of the Emotion Regulation Questionnaire was revised by Chen et al. [77] to measure ER strategies. The questionnaire is composed of two opposing dimensions. Each of them consists of 10 items rated on a 7-point Likert scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). 4 items assess the degree of expressive suppression (e.g., "*I controlled my emotions by not expressing them*") as well as 6 items assess the degree of cognitive reappraisal (e.g., "*When I wanted to feel less negative emotion, I changed the way I was thinking about the situation*"). The cumulative score of each item is the total rough score which ranges from 10 to 70. A higher score is judged as greater use of the specific emotion regulation strategy. Regarding the hypotheses, only cognitive reappraisal strategies were adopted in the mediation model. Within the scope of the research, the internal consistency reliability of the employed scale was recalculated (Cronbach's alpha = 0.82 & McDonald's Omega = 0.82).

Psychological resilience scale

The Connor-Davidson Resilience Scale (CD-RISC) is considered as an efficient instrument to measure the ability to cope with stress and adversity [78]. The adapted Chinese version of the CD-RISC assessing personal resilience during the last month has adequate content validity, internal

consistency, and test-retest reliability [79]. This 25 items scale contains three factors: optimism, strength, and tenacity. All these items carry a 5-point range of responses as follows: "*0 = not true at all, 1 = rarely true, 2 = sometimes true, 3 = often true, 4 = true nearly all of the time*". Consequently, the total score can be computed by adding up the responses (values) of all items, ranging from 0 to 100. Higher scores reflect a greater degree of psychological resilience and recovery ability. Within the scope of the research, the internal consistency reliability of the employed scale was recalculated (Cronbach's alpha = 0.91 & McDonald's Omega = 0.92).

Event-related rumination inventory

The Chinese Event-Related Rumination Inventory was revised to measure rumination [80]. The full scale consists of 20 items, the former 10 items describe intrusive rumination and the later 10 items describe deliberative rumination. Respondents were asked to use a 4-point Likert scale scoring method to express their attitude toward each item, ranging from 0 (*never*) to 3 (*always*). Regarding the hypotheses, only deliberative rumination items were adopted in the mediation model, so the theoretical score ranges from 0 to 30. The higher score indicates a higher frequency of deliberative rumination. The DR scale here captured how the respondents felt over the past 2 weeks and was emphasized the COVID-19 epidemic consideration by specific instructions at the beginning of the scale. Within the scope of the research, the internal consistency reliability of the employed scale was recalculated (Cronbach's alpha = 0.93 & McDonald's Omega = 0.93).

Statistical analyses

Data processing was performed with IBM SPSS Statistics for Windows, Version 28.0 (SPSS; IBM, Armonk, NY, USA). The sociodemographic characteristics were all categorical variables and were reported as numbers and percentages. A common method variance test was performed using Harman's single-factor test according to the cross-sectional nature of our research design, following the criteria of Podsakoff et al. [81]. Before starting the analysis, the assumptions about the normal distribution of the dataset were checked. The outputs of the Shapiro-Wilk test revealed that variables were skewed distributed ($p < 0.05$), except for PR. Descriptive statistics and bivariate correlation (r) analyses were conducted using SPSS 28.0. Considering the normal distribution results, the main numerical variables were represented by median (interquartile range), and relationships among these variables were computed by Spearman analyses. Meanwhile, non-parametric Mann-Whitney-Wilcoxon (MWW) test and t test were used to compare the differences in PC, CR, PR, DR and PTG among students in different groups of categorical variables (MWW for PC, CR, DR and PTG; T for PR). Finally, the serial multiple mediation hypothesis was tested using Preacher and Hayes's method in PROCESS Macro using SPSS 3.4. Four models were fitted: regressing the first mediator (CR) on the predictor (PC), regressing the second mediator (PR) on the first mediator and predictor, regressing the third mediator (DR) on the first mediator and predictor, and regressing the outcome on all mediators and predictors. A non-parametric bootstrap approach was applied to test the total, direct, and indirect effects and calculate bias-corrected percentile confidence intervals (CIs) by constructing 5000 resamples with an original sample size of 463; each resample was constructed by sampling cases from data with replacements. The absence of zero in the 95% CI of the path coefficient indicates that the mediation effect was significant. All analytical tests were two-sided, and the alpha level was set at $p < 0.05$ to determine statistical significance.

Results

Baseline characteristics of the participants

Sample characteristics regarding the sociodemographic data are provided in Table 1. Excluding invalid questionnaires of 24 participants, the final sample size was 463 (effective recovery rate was 95.1%). To ensure an appropriate statistical power and effect size, a *post hoc* statistical power calculator (G*Power, version 3.1.9.7; Heinrich Heine University Düsseldorf) [82,83] was applied with a medium effect size ($f^2 = 0.15$) as well as a significance level of 0.05 [84,85]. Given the final sample size (n = 463) and number of predictors (4), we achieved an observed power (1-β) over 0.99, which is greater than the conventional adequacy standard of 0.80 [74].

Among the enrolled 463 respondents, 365 (78.83%) were female. The majority (78.2%) of the sample were 2nd and 3rd year undergraduates; 18.8% were first year undergraduates. Over all, approximately one in five of the sample (20.5%) were medical students. Almost half of the sample (44.5%) reported that they were from multiple-child families and over half (59.4%) lived in urban areas. Furthermore, regarding the awareness of the COVID-19, participants considered more about their physical and mental health

TABLE 1

Socio-demographic characteristics of the sample (n = 463)

Category	Subcategory	Frequency (*n*)	Percentage (%)
Gender	Female	365	78.8
	Male	98	21.2
Grade	1	87	18.8
	2	211	45.6
	3	151	32.6
	4	10	2.2
	5	2	0.4
	Other	2	0.4
Major	Medical	95	20.5
	Non-medical	368	79.5
Residence	Urban	275	59.4
	Rural	188	40.6
Family	Only child	257	55.5
	Multiple-children	206	44.5

during the epidemic (3.13 ± 1.05) and showed a positive attitude toward the situation (4.41 ± 0.85). Most of them approved of the local government's prevention measures and were not worried about the future epidemic in China (1.70 ± 0.65).

The comparative analyses were conducted to explore the differences in PC, CR, PR, DR and PTG among students in different groups of the above categorical variables. No statistically significant difference was found in Grade, Major, and Residence. Only the students grouped by Gender and Family had a significant difference in PR. The PR of male students was significantly higher than that of female students (2.56 ± 0.51 *vs.* 2.42 ± 0.49, $t = 2.52$, $p < 0.05$). Also, the PR of students coming from only child families was significantly higher than that of students coming from multiple-child families (2.51 ± 0.48 *vs.* 2.38 ± 0.49, $t = 2.79$, $p < 0.01$).

Common method variance test

First, an explanatory factor analysis (EFA) including all items using unrotated principal components factor analysis to reduce dimensionality was conducted to statistically measure the common method's degree of variation. The results revealed that there are 13 factors with eigenvalues greater than 1, and the largest variance of any one factor was 24.36%, which did not exceed the critical value of 40% [81,86]. Thus, there was no evidence of serious CMV in the present study. That is to say, the variation between the dependent and independent variables was caused more by differences in the nature of the variables than by the data collection and measurement methods. Second, a full collinearity test was also performed in order to test the CMV among the present research instruments. Calculated based on the formula $VIF_j = 1/(1\text{-}R_j^2)$ (R_j^2 is the coefficient of determination, the measurement coefficient obtained by regression with other independent variables; variance inflation factor, VIF). As Kock [87] proposed, the occurrence of a VIF greater than 3.3 indicates pathological collinearity, which also means that CMV might contaminate the model. However, it has been found that all VIF values resulting from the full collinearity test turned out to be lower than 3.3 (ranging from 1.05 to 1.68). Altogether, the tests above concluded that this study is considered free of CMV.

Descriptive statistics and pairwise correlations

Descriptive statistics and a correlation matrix of the study variables are displayed in Table 2. According to the normal distribution of the present data, the scores of PC, CR, PR, DR and PTG were described by first quartile (Q1), Median and third quartile (Q3). Moreover, non-parametric Spearman correlation analysis was undertaken to calculate relationships among the research variables. The bivariate correlation results were also given in Table 2 and showed that PC, CR, PR, DR, and PTG were positively correlated with each other ($p < 0.05$). These interrelationships result above were generally in line with our expectations, which met the prerequisites for further research hypotheses and conducting mediation testing.

Serial mediation effects analyses

For further testing the mediation effects, a serial multiple mediation model was performed in PROCESS (Model 81) for SPSS [88], using PC as a predictor, three mediators (CR, PR and DR), and PTG as the outcome. The conceptual model (see Fig. 1) is based on four linear regression analyses. The first regression analysis tests the effects of PC on CR (path a1). The second regression model tests the combined predictive effects of PC and CR on PR (paths a2 and c1). The third regression model tests the combined predictive effects of PC and CR on DR (paths a3 and c2). The fourth regression predicts the PTG by the independent variable PC and the three mediators (paths b1, b2, b3 and d). Here, path d depicts the direct effect of PC on the PTG controlled for the effects of the three mediators. In contrast, path d' indicates the total effect of PC on PTG without considering the mediators.

Model indices are given in Table 3. In the path of a1 → b1, PC positively predicted CR ($\beta = 0.72$, $p < 0.001$). However, CR was not a significant predictor of PTG ($\beta = 0.01$, $p > 0.05$). In the path of a2 → b2, PC positively predicted PR ($\beta = 0.51$, $p < 0.001$), while PR positively predicted PTG ($\beta = 0.60$, $p < 0.001$). In the path of a3 → b3, PC positively predicted DR ($\beta = 0.15$, $p < 0.05$), while DR positively predicted PTG ($\beta = 0.34$, $p < 0.001$). In the path of a1 → c1 → b2, CR had a significant positive effect on PR ($\beta = 0.12$, $p < 0.001$), meanwhile, in the path of a1 → c2 → b3, CR had a significant positive effect on DR ($\beta = 0.10$, $p < 0.01$) (Fig. 2).

TABLE 2

Descriptive statistics and correlation matrix

Variables	Median (Q1, Q3)	PC	CR	PR	DR	PTG
PC	2.00 (1.75, 2.33)					
CR	5.50 (48.3, 6.00)	0.42***				
PR	2.44 (2.16, 2.80)	0.58***	0.41***			
DR	1.60 (1.00, 2.00)	0.19***	0.18***	0.10*		
PTG	2.62 (1.95, 3.24)	0.49***	0.29***	0.51***	0.31***	

Abbreviations: PC, Positive Coping; CR, Cognitive Reappraisal; PR, Psychological Resilience; DR, Deliberate Rumination; PTG, Post-traumatic Growth. *$p < 0.05$, ***$p < 0.001$ (2-tailed test).

TABLE 3

Regression results for mediation analysis

Model	Outcome	Predictors	β	SE	t	LLCI	ULCI
Model1	CR	constant	3.96	0.15	26.74***	3.67	4.26
		PC	0.72	0.07	9.97***	0.58	0.86
			R^2 = 0.18, F = 99.37***				
Model2	PR	constant	0.80	0.12	6.73***	0.56	1.03
		PC	0.51	0.04	12.92***	0.43	0.59
		CR	0.12	0.02	5.06***	0.07	0.16
			R^2 = 0.40, F = 150.52***				
Model3	DR	constant	0.65	0.20	3.29***	0.26	1.03
		PC	0.15	0.07	2.33*	0.02	0.28
		CR	0.10	0.04	2.67**	0.03	0.18
			R^2 = 0.04, F = 10.83***				
Model4	PTG	constant	−0.50	0.28	−1.82	−1.04	0.04
		PC	0.48	0.10	4.73***	0.28	0.69
		CR	0.01	0.05	0.23	−0.09	0.12
		PR	0.60	0.10	5.82***	0.40	0.80
		DR	0.34	0.06	5.51***	0.22	0.46
			R^2 = 0.31, F = 51.00***				

Abbreviations: PC, Positive Coping; CR, Cognitive Reappraisal; PR, Psychological Resilience; DR, Deliberate Rumination; PTG, Post-Traumatic Growth. *p < 0.05, **p < 0.01, ***p < 0.001.

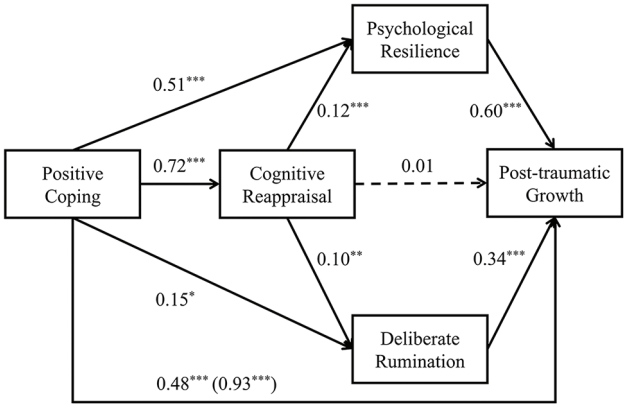

FIGURE 2. Path analysis of positive coping, cognitive reappraisal, psychological resilience, deliberate rumination and post-traumatic growth among Chinese college students (N = 463). The total effect of positive coping without consideration of the mediators is shown in parentheses. *p < 0.05, **p < 0.01, ***p < 0.001.

For the prediction of PTG (Table 4), PC was a statistically significant and positive predictor (b = 0.93, p < 0.001; 95% CI [0.76–1.09]) in the total effect model without consideration of the mediators (d'). However, the explained variance increased by ΔR^2 =0.1 when the mediators CR, PR and DR were included in the model. All possible indirect effects were significant (a2 → b2: b = 0.31, 95% CI [0.19–0.42]; a3 → b3: b = 0.05, 95% CI [0.01–0.11]; a1 → c1 → b2: b = 0.05, 95% CI [0.02–0.08]; a1 → c2 → b3: b = 0.03, 95% CI [0.01–0.05]) except path a1 → b1 (b = 0.01, 95% CI [−0.07–0.09]). Correspondingly, both the total indirect effect (b = 0.44, 95% CI [0.30–0.58]) and the direct effect of PC on PTG (d) were significant (b = 0.48, p < 0.001; 95% CI [0.28–0.69]). The effect size of the intermediary pathways was calculated using the formula (ab)/c, showed that path a2 → b2, a3 → b3, a1 → c1 → b2 and a1 → c2 → b3 accounted for 33.33, 5.37, 5.37 and 3.23% of the total effect, respectively. According to the above analysis results, the research hypotheses H1-H6 passed the test except H2. These indicated that the PC was closely related to students' CR, PR, DR and PTG. PC was positively predictive of PTG in an indirect manner with PR and DR as parallel mediators. More importantly, PC could also enhance PR and DR by improving the adoption of CR, which finally facilitated students' PTG.

Discussion

Since the so-called "second wave" of the COVID-19 outbreak that started in August 2020, science has made great strides in implementing appropriate infection prevention strategies to control virus propagation, particularly profit from vaccine development [89]. However, small-scale epidemics continue to emerge in some areas, and predictions of future scenarios point to a possible coexistence with COVID-19 in the following years, underlining the necessity of addressing the psychological aftermath of the pandemic [90,91]. As is well known, this pandemic has brought about changes in the way college students' study and socialize, which also poses a threat to their mental health [9]. Given the reach of the COVID-19 pandemic and the current focus on negative mental health sequelae, there is a gap in alternative paradigm research examining whether positive aspects are achievable and how this can be done.

TABLE 4

Effects and 95% confidence intervals for the serial mediation model

Pathways	Effect	BootstrapSE	*t*	LLCI	ULCI
Total effect	0.93	0.08	11.00***	0.76	1.09
Direct effect	0.48	0.10	4.73***	0.28	0.69
Total indirect effect	0.44	0.07	—	0.30	0.58
PC→CR→PTG	0.01	0.04	—	−0.07	0.09
PC→PR→PTG	0.31	0.06	—	0.19	0.42
PC→DR→PTG	0.05	0.03	—	0.01	0.11
PC→CR→PR→PTG	0.05	0.02	—	0.02	0.08
PC→CR→DR→PTG	0.03	0.01	—	0.01	0.05

Abbreviations: PC, Positive Coping; CR, Cognitive Reappraisal; PR, Psychological Resilience; DR, Deliberate Rumination; PTG, Post-Traumatic Growth. LLCI, Boot CI lower limit; ULCI, Boot CI upper limit. ***$p < 0.001$.

This study concentrated on college students during the later pandemic period in the Chinese context. Concerning COVID-19 awareness, students have paid more attention to their physical and mental health and showcased hope and optimistic attitudes toward the present situation during the pandemic. Most were satisfied with local government prevention policies and were not anxious about future recurrences in China. These findings may provide ample evidence that despite being severely affected by the pandemic, Chinese public health agencies have made considerable progress in the prevention of COVID-19. Chinese students were securely guarded by the Home Quarantine Order and regularly carried out nucleic acid test screening. In addition, Chinese colleges and universities have formulated flexible teaching programs for students through online course arrangements, as appropriate to guarantee the learning schedule. Furthermore, considering this ongoing pandemic, colleges have also conducted vigorous advocacy about outbreak responses and buffered the panic caused by a variety of mass media platforms. These countermeasures accelerated students' opportunities for growth in the context of the COVID-19 aftermath. Indeed, descriptive statistics confirmed psychological rebound and recovery in our sample. Our survey was conducted more than one year after the initial outbreak. As PTG is suggested to emerge over a period of time, it logically follows that college students have had enough time to adapt to such severe life-threatening situations and have already fulfilled positive changes.

In general, the hypothesized model fit the data well, indicating that PC can predict PTG through the mediating roles of CR, PR, and DR. Our results supported Hypothesis 1 and were consistent with previous research, in which a positive relationship between PC and PTG was found. This means that college students prefer to implement adaptive coping strategies to deal with major life crises and seem to report an increased likelihood of PTG. There is evidence that college students who are more optimistic and use PC strategies are more willing to participate in social activities and eliminate the adverse impact of stress. These adaptive strategies seemed to help them reform their views on the present pandemic and consequently facilitate them in overcoming COVID-19-related problems [74]. Consequently, a sense of increased personal strength is more likely to arise when someone judges that they have coped. Coping is accepted as "a transactional process between individuals, the context, and post-trauma outcome" [92]. A considerable number of available studies have reported that individuals who have experienced trauma can identify an array of positive ways in which their lives have changed and that these are conducive to improved mental health and well-being. The more they reconsider the situation (positive reframing), pray, and meditate for stress relief (turn to religion), relying on their social networks for instrumental support, the more likely PTG is to emerge [23].

PC encompassed several active strategies, including cognitive reappraisal, problem-solving, and help-seeking [93], which are associated with higher levels of positive cognitive and behavioral adjustments to directly reduce or control stress [94]. In terms of the intermediary model, the present findings supported the proposed Hypothesis 3 and 4. To be specific, PR and DR, respectively, mediated the relationship between PC and PTG in the context of the COVID-19 aftermath. Firstly, PR is defined as an internal resource to cope with or overcome a variety of adversities and perceived stress, reflecting problem-solving ability or positive adaptation [95]. A previous study investigated the relationship between PTG and PR among nursing university students after the COVID-19 alarm status in Turkey and found a predictive effect of PR on PTG [96]. During this kind of emerging health crisis, psychologists consider using social media and internet to target college students in a timely manner when sharing self-help strategies, such as cultivating resilience and positive emotions [46]. The majority of research on the mental health impact of the COVID-19 pandemic has documented that improving PR can cushion the college students' psychological stress and contribute to their academic success [97] and develop their sense of well-being [98]. As expected, students in our study who used more PC strategies to identify positive meanings for personal growth presented higher levels of PR, supporting the above claims. Secondly, along with recent PC, empirical evidence has highlighted the central role of posttraumatic cognitive engagement (e.g., ruminations) in

PTG in the aftermath of trauma [13]. Rumination processes that initially run unexpectedly instigate coping processes and are replaced by reorganization of beliefs to find positive implications in stressful events and integrate the experiences into the life narrative. The emerging sense of comprehensibility inclines individuals to figure out ways to reconsider the changed circumstances and then may bring about PTG. Regarding PTG, a positive influence of DR on PTG is found when controlling for intrusive rumination [65,99]. DR focuses on the meaning of the traumatic event and takes place after initial coping attempts, which may be comparable to "meaning-focused coping" [99]. We found that coping with COVID-19-related stressful events was directly associated with higher levels of PTG, and such a link could be indirectly mitigated by DR. It could be conceivable that through reflective DR, students might be able to process the COVID-19 experience intentionally, free themselves from being emotionally stuck in the trauma, and integrate the event into their life story [65], which may enable them to effectively achieve growth.

Notwithstanding that a growing body of literature has given considerable attention to PTG studies focusing on CR —a kind of ER strategy to positively reinterpret a stressor to mitigate or control its emotional impact [58], the mediation analysis results did not confirm that the impact of PC on PTG is mediated by CR. However, two hypothesized serial mediations conclusively fit the data and provide a framework for how CR contributes to PTG for the first time (Hypothesis 5 and 6). Supporting the tendency to look for PC to adjust emotions seems to be a remarkable opportunity to develop personal resources that increase people's level of wellbeing and PTG in the face of difficult and traumatic life events. Our results verified the chain mediating effect of CR and PR. Based on the "broaden and build" theory developed by Fredrickson, positive emotional states may mediate various types of behavioral phenomena, and are especially associated with resilient functioning [100]. The use of effective coping skills to regulate emotional experience during or after adversity is an example of an adaptive process underpinning resilience [101]. Here, PC plays a positive role in CR. Their common core emphasizes that protective factors provided to individuals facing adversity determine the higher level of PR and ultimately their PTG development. The chain mediating effect of CR and DR was also verified. When confronting the debilitating effects of COVID-19, students who use more PC facilitated more CR strategies, and then improved DR tendencies, thereby encouraging them to facilitate more PTG.

Although the relationship between PC and PTG was dealt with in the context of CR, PR, and DR, which are discussed by considering the constructed models considering the COVID-19 aftermath, several limitations must be considered. On the one hand, all demographics and primary psychological variable assessment data were collected via the convenience sampling method. The under-representation of certain subgroups did not permit the generalizability of the findings [36]. For further research, a more organized, comprehensive sample technique should be implemented. Although the online survey was carried out with the assistance of course teachers by disseminating a questionnaire hyperlink or an electronic QR code before or after class, the possibility of bias exists because the participants that had responded to this survey tended to take things positively, and some other students might be loath to participate due to a lack of time, task overload, or wanting to avoid everything related to the COVID-19 pandemic. Moreover, females make up close to 80% of all subjects and the comparison to male subjects must be considered to avoid faulty generalizations. Future studies with a more robust sample size of male students, for example, covering more male-centered college majors with adequate sampling methods, may further enhance the power to identify the effect of gender on PTG and other variables. In addition, this study evaluated PTG only once through a web-based self-administered questionnaire rather than more objective measures of growth or development. As such, these data might lack representability or be subject to (bidirectional) potential response bias [102]. Future research should consider the principle of voluntariness and raise concerns regarding the extent to which participants developed actual growth.

On the other hand, because all the above investigations are retrospective and cross-sectional in nature, the current model does not allow us to establish definite inferences about the causality of these investigated variables. Prospective longitudinal design and experimental/intervention studies are required to corroborate the causal linkage and dynamic shifts. When it comes to data interpretation, mediators/moderators might also be correlated with unobserved prognostic variables which may confuse the findings. Therefore, it is essential to employ a multimodal approach or assess the possibility of other underlying pathways to resolve this matter and open up new research perspectives linking different variables.

Conclusion

Taken together, this study is expected to provide a theoretical supplement to the research in related fields of positive psychological resources among college students during the aftermath of COVID-19, which may guide policymakers and practitioners in developing tailor-made preventive and supportive psychosocial intervention procedures. Promoting PC strategies such as changing lifestyles while adhering to COVID-19 may be particularly beneficial in taking a realistic and adaptive approach to foster long-term adaptations successfully. For example, participating in distraction exercise, reading different books, taking proper rest social interaction with individuals to be trusted as well as using different entertainment TV channels and internet sites in the time of COVID-19 are the most appropriate, effective and efficient coping strategies [103]. Meanwhile, colleges should improve their students' psychological training and mental health education in the time of COVID-19 and develop cutting-edge strategies to manage negative emotions. Novel theoretical and empirical insights into the comprehension of how PC may support PTG through CR, PR, and DR are recommended. Adopting more proactive coping strategies to deal with the severe impact of COVID-19 is beneficial to transform the negative perception

of the distress into a positive one through CR, and this cognitive change could further strengthen the capability to rally from adverse events as well as rebuild the faith of living intentionally, which will bring a better adaption during this critical period and finally realize positive growth. We hope that our efforts will stimulate further exploration and extensive discussion concerning ways to recover and grow from traumatic events. Notably, university life is a process of adaptation to changes at the juncture between school and social life; undergraduate students, in particular, undergo a critical transitional period [104]. These populations require more help and support from society, families, and colleges to go through major life crises. In addition, to improve a higher level of students' mental health and well-being, the government and schools ought to pay due attention to the specific aspects of PTG and collaborate to provide high-quality psychological care to college students.

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