ORIGINAL RESEARCH

Post-traumatic growth and influencing factors among frontline nurses fighting against COVID-19

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ABSTRACT

Objective To explore the level and influencing factors of frontline nurses' post-traumatic growth (PTG) during COVID-19 epidemic.

Methods A cross-sectional survey was conducted in February 2020 in three hospitals in China. The Post-traumatic Growth Inventory (PTGI) was used to investigate the PTG of frontline nurses. Data on related factors, including demographic characteristics and subjective variables, were collected. The Event-Related Rumination Inventory was used to assess rumination. Pearson's or Spearman's correlation was calculated for bivariate analysis. Independent sample t-tests or one-way analysis of variance and multiple linear regression analysis were used to examine the related factors.

Results A total of 179 frontline nurses were recruited, and 167 were included in the analyses. The mean PTG score was 70.53±17.26. The bivariate analyses showed that deliberate rumination was modestly positively correlated with PTG (r=0.557, p<0.01), while intrusive rumination had a modest negative correlation with PTG (r=−0.413, p<0.01). Multiple linear regression demonstrated that working years, self-confidence in frontline work, awareness of risk, psychological intervention or training during the epidemic and deliberate rumination were the main influencing factors of PTG among frontline nurses and accounted for 42.5% of the variance (F=31.626, p<0.001).

Conclusions The PTG of frontline nurses was at a medium to high level and was influenced by working years, self-confidence in frontline work, awareness of risk, psychological intervention or training and deliberate rumination. It is necessary to strengthen psychological guidance and training for frontline nurses and promote their deliberate rumination on epidemic events to improve their PTG.

Key messages

What is already known about this subject?
► Previous studies have found that nurses may experience psychological stress reactions while working on the frontline of a communicable disease epidemic.
► Recent evidence indicates that individuals can grow as a result of trauma or stressful events, which means individuals might achieve post-traumatic growth.
► There is limited evidence about frontline nurses' post-traumatic growth and related factors.

What are the new findings?
► A cross-sectional survey of post-traumatic growth among nurses who worked on the frontline fighting against COVID-19 found that post-traumatic growth was at a medium to high level.
► Frontline nurses' post-traumatic growth was influenced by their working years, self-confidence in frontline work, awareness of risk, psychological intervention or training and deliberate rumination.

How might this impact on policy or clinical practice in the foreseeable future?
► Nurses experience growth from their work experience during the COVID-19 epidemic. Interventions targeting self-efficacy and risk awareness before and during work on the frontline of the epidemic are suggested. Psychological intervention or training should also be strengthened. Remarkably, it is helpful to guide nurses to purposefully and constructively reflect on their work experience and identify the significance of this experience to improve their post-traumatic growth and future work.

INTRODUCTION

The COVID-19 epidemic is a major public health emergency and threat to human health. Because of the high infectivity of the 2019 novel coronavirus (2019-nCoV), which has an estimated basic reproductive number of 2.2 (95% CI 1.4 to 3.9),[1] and the general population's susceptibility to 2019-nCoV,[2] the epidemic has spread rapidly. Since the outbreak in December 2019, there have been 85 194 cumulative confirmed cases reported in China, and 4634 deaths as of 24:00 on 13 September.[3] Globally, there were 26 763 217 confirmed cases and 876 616 deaths by 6 September.[4] More than 90 national and provincial medical teams with approximately 13 000 healthcare workers have been sent to Hubei from other regions to provide assistance.[5] Additionally, China implemented hospital classification management. The best hospitals were designated for COVID-19 confirmed cases.[6] In the designated hospitals, the nursing office requested each department to nominate one to two nurses as a backup nursing team for COVID-19 wards (fever clinic, isolation ward and so on).[7] These nurses were reallocated and supported the front line in different

echelons. For each echelon, support tasks were divided into three stages: preparing, working in COVID-19 wards for 14 days and then isolating at a designated place for another 14 days. The nursing department obtained the information about COVID-19 wards everyday through WeChat group and provided consultation and guidance. The chief nursing officer timely adjusted the staff to ensure optimal allocation of nursing personnel. During the crisis, all available resources were centralised for the frontline departments.

Remarkably, although protective measures were taken, the most recent single-centre study still reported 40 (29%) medical staff were infected in hospital settings.[8] In this study, 26% of confirmed patients required admission to the intensive care unit and 4.3% died. After witnessing a large number of infected patients and the deaths of severely ill patients, nurses may experience nightmares and intrusive thoughts about work scenes in the early stages of frontline work, resulting in greater psychological distress. Previous studies indicated that 85.4% of frontline nurses reported psychological stress reactions, such as somatisation and obsessive–compulsion,[9] and psychological distress reached a moderate level (4.42 on a scale of 10).[10] Possible reasons might be a lack of familiarity with COVID-19 and concerns about potential risks to themselves or their loved ones. However, a study showed that as nurses became familiar with the frontline work procedures, they began to show psychological adaptation and experience feelings of satisfaction and pride.[11]

A previous study revealed that perceived distress and positive affect were associated with post-traumatic growth (PTG).[12] PTG is a concept that was proposed by Tedeschi et al,[13] which refers to positive psychological changes after an individual experiences traumatic events. That is, people have the ability to grow as a result of trauma. After frontline work, nurses may experience some positive changes. Exploring these changes may help them reflect on their experience and find meaning in it, which may mitigate the negative effect of traumatic work-related experiences and improve their satisfaction with life.[14] The PTG model proposed by Tedeschi and Calhoun[15] suggests that rumination is an important cognitive process that leads to individual growth through traumatic events or negative changes. However, previous studies have mainly focused on the negative emotions of frontline nurses.[9–11] The purpose of this study is to evaluate the level of PTG and its influencing factors among frontline nurses, analyse the relationship between PTG and rumination and provide a basis for targeted intervention of frontline nurses.

METHODS
Design and sample
This survey, part of a psychological intervention study for nurses combating COVID-19 in frontline departments, was conducted in three designated hospitals. These three hospitals, located in intense areas of COVID-19, were among the best hospitals in Henan and Hubei Provinces and designated for COVID-19 confirmed cases with more severe and complex conditions. Nurses from the frontline departments of these three hospitals were recruited for the online survey in February through WeChat, a social media application. The inclusion criteria were as follows: (1) was older than 18 years old; (2) was working in a frontline department during COVID-19; and (3) provided informed consent.

A Chinese online questionnaire app was used to design an electronic questionnaire for this study. Unique two-dimensional codes linking to the questionnaire were sent to three liaison nurses from the three hospitals via WeChat and then sent to

the WeChat group for the frontline departments of the three hospitals. The survey contained unified instructions that introduced the purpose and significance of the study. Nurses who agreed to participate were required to click the 'Agree' button to start the survey; if they did not click the button, they were regarded as not agreeing to participate, and they were not given access to the online survey. Each WeChat account could submit only one questionnaire, which avoided the possibility of double registration. To ensure the quality of participants' responses, we discarded questionnaires that were completed in less than 5 min. Additionally, to avoid missing data, each question was designed to require an answer. Question logic was used to reduce the number of invalid questionnaires. For example, the response for working years was required to be a positive integer.

Measures
The online questionnaire investigated the demographic characteristics of the respondents, including age, gender, marital status, whether they had children, educational background and religious beliefs.

It also included closed-ended questions about work-related variables, such as working years (how many years have you worked as a nurse?), professional title (what is your title as a nurse, junior, middle or senior?), previous rescue experience in public health emergencies (have you ever participated in the rescue of major public health emergencies?), psychological intervention or training during COVID-19 (have you received psychological intervention or training during COVID-19?), feeling of being well prepared (do you feel well prepared for frontline work?), confidence about frontline work (do you feel confident about frontline work) and awareness of the risk (how risky is frontline work, high or low?).

PTG was measured by the Post-traumatic Growth Inventory (PTGI), which is a 21-item questionnaire with five factors: relating to others, new possibilities, appreciation of life, personal strength and spiritual change.[16] Participants responded on a 6-point Likert scale, 0 for no change and 5 for complete change.[16] The simplified Chinese version of PTGI (PTGI-C) contained 20 items after culture adaptation (item 18 'I have stronger religious faith' was removed), but the dimensions remained consistent with the original scale.[17] The total score ranges from 0 to 100, with higher scores indicating higher levels of PTG. Previous studies endorsed that a mean item score of PTGI >3 and total score >60 reached moderate and above levels of PTG.[18 19] This study adopted the above criteria. The Cronbach's alpha value of PTGI-C was 0.947 in our sample, suggesting good reliability for frontline nurses.

Rumination, an important post-traumatic cognitive process, was measured by the Event-Related Rumination Inventory (ERRI). ERRI items are scored on a 4-point Likert scale from 0 ('I never think of this after the experience') to 3 ('I often think of this after the experience').[20] The total score of the 20 items ranges from 0~60 and reflects the general level of rumination. The scale includes two factors: intrusive rumination and deliberate rumination. The simplified Chinese version showed good psychometric properties among individuals who experienced unintentional traumatic events, such as injuries incurred while working.[21] The Cronbach's alpha values were 0.964, 0.944 and 0.949 for the whole scale, intrusive rumination and deliberate rumination, respectively, indicating good reliability for frontline nurses.

Ethics statement

The online survey was anonymous, and consent was obtained when participants accessed the online link.

Statistical analysis

Descriptive analyses of the characteristics of the participants were conducted. All variables were treated as categorical variables. Cut-off points for age and working years were chosen according the median value and IQR to ensure balance in each stratum. Independent sample t-tests, one-way analysis of variance with Levene test to assess homogeneity of variance, and Pearson or Spearman correlation analyses were performed to examine the differences in and relationships between participants' characteristics, rumination and PTG. To determine the influencing factors and the best model that explained PTG, a stepwise selection linear regression strategy was employed. The nurses' characteristics and rumination were used as independent variables. Intrusive and deliberate scores were included to better understand how rumination types relate to PTG. All variables were sequentially added to the model and retained only if they were significant to arrive at the final model. The final model estimates the mean change in PTG and standardised regression coefficient (β) for the linear trend for a given independent variable as well as the 95% CIs. The best model was assessed with R square. All statistical analyses were performed with IBM SPSS V.21.0. The alpha values were two tailed. The p value for statistical significance was set at 0.05.

RESULTS

Descriptive analysis of participants

A total of 179 questionnaires were sent out, and 171 were returned. After questionnaires showing patterned responses were discarded, 167 responses remained, for a 93.3% effective response rate.

As shown in table 1, the participants were predominately female (92.8%), with a median age of 30 years. More than half of them were married, and 44.3% had children. A total of 87.5% had a bachelor's degree and above. A total of 95.8% had no religious beliefs. The median years of employment was 6. Nearly two-thirds held a junior professional title. More than 90% had no experience in public health emergency rescue, and 73.7% had received no psychological intervention or training during COVID-19. Over one-third did not feel well prepared for work in frontline departments, and approximately one-fifth were not confident about frontline work. More than two-thirds perceived frontline work as high risky.

Univariate analyses of the factors associated with PTG

Univariate analyses showed that nurses who were older, were married, had a higher level of education, had a higher professional title and had more working years had higher PTG scores (p<0.05). Nurses who had participated in previous major public health emergencies, had received psychological intervention or training during COVID-19, had confidence about performing frontline work and were aware of the high risk of frontline work also had a higher level of PTG (p<0.01) (see table 1).

PTG and rumination scores of frontline nurses

The total PTG and rumination scores were 70.53±17.26 and 26.43±11.91, respectively. A total of 43.7% of participants had average levels of PTG. The appreciation of life dimension had the highest item mean score (3.77±1.09) (see table 2). The scores for item 2 ('An appreciation for the value of my own life'),

item 19 ('I learnt a great deal about how wonderful people are') and item 4 ('A feeling of self-reliance') ranked in the top three (mean score=4.05, 3.97 and 3.84, respectively) for the PTGI (online supplemental appendix 1).

Bivariate analysis of individual characteristics, rumination and PTG

There was a moderate positive correlation between PTG and rumination (r=0.517, p<0.01). Deliberate rumination was modestly positively correlated with PTG (r=0.557, p<0.01), while intrusive rumination had a modest negative correlation with PTG (r=−0.413, p<0.01). There were positive correlations of PTG with age, education, working years, professional title, previous experience in public health emergencies, psychological intervention or training during COVID-19, feeling well prepared for frontline work, confidence about frontline work and awareness of the risk of frontline work (r=0.161~0.293, p<0.05) (online supplemental appendix 3).

Multiple linear regression analysis

The multiple regression analysis, which was summarised in table 3, revealed that working years, psychological intervention or training during COVID-19, confidence about frontline work, awareness of the risk of frontline work and deliberate rumination were influencing factors of PTG. These five variables explained 42.5% of the total variance of PTG.

DISCUSSION

PTG is a positive psychological indicator, and it was important for nurses who worked in frontline departments during COVID-19. This study examined frontline nurses' PTG and explored related factors. The relationship between rumination and PTG was also examined.

In our study, the total PTG score among frontline nurses was 70.53±17.26, which was at moderate and above level. This finding suggests that frontline nurses experienced probable PTG. A possible reason might be that during COVID-19, most nurses transferred to frontline departments had worked for 3 years or more and had excellent comprehensive skills.[7] Previous regular training in their original department had given them proficient nursing skills and competencies to respond to clinical emergencies. Although they may have experienced psychological stress, some of their psychological activities developed positively, such as their perception and new understanding of life; the improvement of the relationship among doctors, nurses and patients; self-development; and a change in spiritual outlook, which promoted their growth after this working experience. However, notably, 56.3% of nurses' PTG scores were lower than the average, which needs to be considered.

In an attempt to elucidate independent predictors of PTG, the multivariate results revealed, after adjusting for all the selected variables, that several factors were uniquely related to nurses' PTG. Nurses with more than 10 working years had higher PTG scores. This may be because nurses with more working years show a higher level of critical thinking.[22] Additionally, they were always responsible for the management of critical patients in their original units before being transferred to frontline departments and had rich nursing experience. When confronted with the fast-changing conditions of patients with COVID-19 and frequent emergencies in frontline departments,[23] they could better pay attention to the patient's condition and treatment, think actively and respond quickly and accurately. Moreover, 92.8% of participants in this study were female, and many of

Table 1 Univariate analysis of the post-traumatic growth of frontline nurses (n=167)

Variables	Number, percentage (%)	PTGI score (¯X±SD)‡	Statistical values (t/F)§	P value
Demographic variables				
Age*			3.017	**0.003**
≤30	104 (62.3)	64.31±17.16		
>30	63 (37.7)	72.38±16.07		
Sex			1.149	0.252
Male	12 (7.2)	72.83±23.95		
Female	155 (92.8)	66.93±16.56		
Marital status			2.064	**0.041**
Not married	71 (42.5)	64.20±17.55		
Married	96 (57.5)	69.69±16.58		
Children			1.668	0.097
No	93 (55.7)	65.39±17.19		
Yes	74 (44.3)	69.82±16.92		
Educational background			3.895	**0.002**
Junior college degree	21 (12.5)	55.52±19.07		
Bachelor's degree and above	146 (87.5)	69.44±15.99		
Religious belief			1.023	0.308
No	160 (95.8)	60.86±13.55		
Yes	7 (4.2)	67.64±17.28		
Work-related variables				
Working years†			3.965	**0.009**
≤3	63 (37.7)	62.52±19.02		
4~5	17 (10.2)	64.76±9.99		
6~10	47 (28.1)	69.51±15.76		
>10	40 (24.0)	73.53±16.11		
Professional title			3.856	**0.011**
Junior	107 (64.1)	64.88±17.32		
Middle	53 (31.7)	73.23±16.09		
Senior	7 (4.2)	70.86±18.59		
Previous rescue experience in a public health emergency			2.640	**0.009**
No	151 (90.4)	66.23±17.25		
Yes	16 (9.6)	77.94±12.40		
Psychological intervention or training during COVID-19			2.760	**0.006**
No	123 (73.7)	65.20±17.15		
Yes	44 (26.3)	73.36±15.88		
Feeling of being well prepared for frontline work			1.787	0.076
Not sure	58 (34.7)	64.12±17.22		
Yes	109 (65.3)	69.07±16.96		
Confidence about frontline work			3.999	**0.000**
Not sure	32 (19.2)	56.91±18.30		
Yes	135 (80.8)	69.83±15.98		
Awareness of the risk of frontline work			3.844	**0.000**
Low risk	52 (31.1)	60.06±18.08		
High risk	115 (68.9)	70.65±15.73		

P values in bold are statistically significant.
*The median age of the participants was 30 years old.
†The median number of working years of the participants was 6 years; the 25% and 75% IQR were 3 and 10, respectively.
‡¯X: mean score of PTGI.
§t: statistical value of Student's t-test; F: statistical value of one-way analysis of variance.
PTGI, Post-traumatic Growth Inventory.;

those with more working years were married and had children. They may have had more family and social roles and possibly had stronger personal strength. The results suggest that we should pay attention to the psychological status of nurses with fewer working years, strengthen their epidemic knowledge, improve their coping ability and encourage them to reflect on their experiences.

We found that the nurses who had received psychological intervention or training during COVID-19 had higher levels of PTG. 2019-nCoV is believed to be transmitted mostly via droplets or contact, and no specific drug or vaccine has yet been confirmed to be effective.[24] Nurses were worried about being infected while delivering care.[25] Additionally, most of them had not participated in public health emergency rescue before, had little coping experience and were not well prepared for frontline work.[26] Receiving psychological intervention or training before or during the frontline work period might have helped nurses maintain positive affect and reduce their attention bias to

Table 2 Total scores and subdimension scores of the PTGI and ERRI (n=167)

	Number of items	Dimension (mean±SD)	Item (mean±SD)
PTGI			
Total score	20	70.53±17.26	3.38±1.21
Relating to others	3	12.09±3.21	3.03±1.33
New possibilities	4	13.38±4.02	3.34±1.19
Appreciation of life	6	22.61±5.13	3.77±1.09
Personal strength	3	10.26±2.85	3.42±1.14
Spiritual change	4	12.18±4.24	3.05±1.36
ERRI			
Total score	20	26.43±11.91	1.32±0.77
Intrusive rumination	10	11.98±6.24	1.20±0.76
Deliberate rumination	10	14.45±6.44	1.45±0.78

Online supplemental appendix 1 and 2 in the supplementary material show each item and scores of the PTGI and the ERRI, respectively.
ERRI, Event-Related Rumination Inventory; PTGI, Post-traumatic Growth Inventory.

negative emotions and might have promoted their regulation and release of negative emotions,[27] thus helping them complete high-intensity work in a good psychological state. Furthermore, such intervention or training could stimulate nurses' sense of mission and professional responsibility, generate positive psychological experience and help them achieve growth from frontline work.[28] According to a document from the National Health Commission, medical staff on the front line of epidemic prevention and control are a first-class population for psychological intervention.[29] Currently, there is much online psychological assistance. However, the existing resources mainly targeted the negative emotions of medical staff, such as depression and anxiety.[30] We suggest that follow-up interventions should pay attention to the positive changes that emerge during the experience of frontline work to improve nurses' PTG.

Frontline nurses who felt confident about frontline work and recognised the high risk showed a higher level of PTG. They got much support from the hospital, their colleagues in the same echelon, as well as their families and friends, which may help them keep confident about combating COVID-19. Nurses who were confident in their work might have had higher self-efficacy and more active attitude towards their tasks. A previous study found that self-efficacy was positively related to nurse resilience, which may help foster nurses' job resources and ultimately help them achieve personal growth.[31] In our study, nurses with more confidence may have viewed the experience fighting against COVID-19 as a test on the road of life, and such a view may have

been conducive to them fully mobilising their personal strength, striving to pursue and achieve their own goals and discovering beneficial elements for their own health to generate positive psychological feelings and prompt more growth. In this study, 68.9% of the nurses regarded frontline work as highly risky. Because of a strong sense of collectivism, frontline nurses may show higher worries and concerns for their patients and other team members in the echelon than for themselves.[32] Nurses' risk appraisal of the threat of COVID-19 may have influenced their understanding of the novelty, severity and complexity of this infectious disease and their responses towards it.[33] Awareness of the high risk may have caused them to pay more attention to and think about the epidemic and rationally analyse the current situation and potential problems, which may have helped them better respond to the emergency situation and better follow the work procedures to avoid being infected. Their rational and positive responses to the experience may have generated positive feelings and enhanced their preparedness for such situations in the future. We suggest that positive attitudes should be enhanced and that reliable information about the epidemic should be provided for frontline nurses to promote their rational thinking about the epidemic and their PTG.

We found that deliberate rumination was helpful for frontline nurses' PTG. According to the model of PTG,[15] cognitive processing, especially constructive cognitive processing, is the key process of PTG. In this study, three items in the deliberate rumination dimension, that is, 'I thought about whether I have learned anything as a result of my experience', 'I thought about what the experience might mean for my future' and 'I thought about whether the experience has changed my beliefs about the world' scored the highest (online supplemental appendix 2). Previous studies found that a challenge to core beliefs was the main predictor of PTG,[34 35] which may be because individuals engaged in deliberate rumination soon after the event.[36] After frontline work, nurses who engage in deliberate rumination may turn their attention to reflecting on the positive aspects and meanings of this experience, as well as the changes it may bring, such as one's outlook of the world and future goals and plans.[37] All of these factors may stimulate nurses' self-growth motivation to help them establish higher levels of goals and beliefs and the ability to manage emotional distress; additionally, these factors may help nurses transform the experience of frontline work into a milestone in life and enhance their sense of professional value to achieve growth. We suggest that nurses should be guided to think positively during the follow-up interventions, so they can explore and reflect on the positive significance of their experience, such as the improved relationship between nurses and

Table 3 The influencing factors of PTGI by multivariable linear regression analysis

	Regression coefficient†	95% CI	β	R square‡
Constant*	45.58	34.701 to 56.458	–	0.438
Working years	2.853	1.189 to 4.516	0.202	
Psychological intervention or training during COVID-19	0.273	0.102 to 0.536	0.129	
Confidence about frontline work	10.457	5.324 to 15.591	0.241	
Awareness of the risk of frontline work	4.930	0.408 to 9.451	0.133	
Deliberate rumination	1.323	0.997 to 1.649	0.496	

F=31.626, p<0.001. Online supplemental appendix 4 in the supplementary material shows the assignment of the independent variables and the reference categories.
*The constant value represents the non-random part of PTGI, which is not explained by the independent variables.
†Linear regression coefficient represents the number of units the dependent variable will change when the independent variable changes per unit, holding all other variables constant. Take 'psychological intervention or training received during COVID-19 and confidence about front-line work' as examples, PTGI scores will increase 0.273 and 10.457, respectively, if frontline nurses answer yes to the questions. The influence order of these variables on frontline nurses' PTGI is as follows: deliberate rumination, confidence about frontline work, working years, awareness of the risk of frontline work, psychological intervention or training during COVID-19 based on the β values.
‡R square was 0.438, and the adjusted R square was 0.425, indicating that approximately 42.5% of PTGI scores could be explained by the model.
PTGI, Post-traumatic Growth Inventory.

patients, unity among echelon personnel and support from family and society to improve their PTG.

Strengths, limitations and suggestions for future research
Our study supplemented the evidence on the PTG of frontline nurses and related factors, which is meaningful for follow-up interventions. There are several limitations. First, there may be response bias. We believe that the response bias may have been bidirectional. Non-response may have been related to lack of time or sense of task overload. Additionally, the respondents may have held more positive opinions about PTG than the non-responders. The lack of information about non-responders is a limitation of this study. Second, due to the cross-sectional design, causal relationships could not be established, and potential changes in PTG over time could not be observed. Third, the frontline nurses included in this survey were from tertiary hospitals and intense areas of COVID-19; thus, the generalisability of the data might be limited to a certain extent, especially for primary hospitals and areas less severely impacted by COVID-19. Future studies can collect longitudinal data to observe changes in PTG and include nurses from primary hospitals, which may provide a clearer idea of when to intervene and who will benefit more from an intervention. Fourth, this survey did not consider social support, coping style, self-disclosure and so on, which could possibly have influenced the results.[38][39] The associations between these variables and PTG could be explored in future research.

CONCLUSIONS
During COVID-19, frontline nurses' PTG was at a medium to high level. Deliberate rumination, more working years, psychological intervention or training during the epidemic, self-confidence and awareness of the high risk of frontline work were important influencing factors. We should strengthen the psychological interventions for frontline nurses, especially those with fewer working years. Interventions should target self-efficacy and risk awareness before and during work in an isolation ward and then guide nurses to purposefully and constructively reflect on their work experience and identify the significance of this experience to improve their PTG and future work.

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