



# What Are the Differences in Psychological Outcomes Between People Who Posted COVID-19-Related Content on Social Media and Those Who Did Not?

Shu Zhang<sup>1</sup>, Yanwen Zhang<sup>2,3,4</sup>, Dini Xue<sup>5</sup>, Huan Zhang<sup>2,3,4</sup>, Miao Chao<sup>2,3,4</sup>, and Tour Liu<sup>2,3,4</sup> ✉

<sup>1</sup>Shanghai Key Laboratory of Mental Health and Psychological Crisis Intervention, School of Psychology and Cognitive Science, East China Normal University, Shanghai, China

<sup>2</sup>Key Research Base of Humanities and Social Sciences of the Ministry of Education, Academy of Psychology and Behavior, Tianjin Normal University, Tianjin, China

<sup>3</sup>Faculty of Psychology, Tianjin Normal University, Tianjin, China

<sup>4</sup>Tianjin Social Science Laboratory of Students' Mental Development and Learning, Tianjin, China

<sup>5</sup>Institute of Developmental Psychology, Beijing Normal University, Beijing, China

**Objective** During the lockdown of cities and home quarantine, media became the only way for people to conveniently get coronavirus disease-2019 (COVID-19)-related information. And media engagement was closely related to psychological outcomes. But fewer researchers took COVID-19-related posting behaviors into consideration. Therefore, the present study aimed at examining the differences in psychological outcomes between people who posted COVID-19-related content on social media and those who did not.

**Methods** The present study included 917 participants (304 males, 613 females) who had answered the questionnaires of media engagement, positive affect, negative affect, depression, anxiety, stress, satisfaction with life, death anxiety, and meaning in life.

**Results** Results of t-tests showed that the Post group had lower levels of negative affect, anxiety, stress, and death anxiety than the Not Post (Npost) group. Network comparison tests indicated that the Npost group's network and the Post group's network differed in global strength, two edge-weights, and node centrality indices.

**Conclusion** The results indicated that more attention should be paid to people who did not post any COVID-19-related content, especially when they have higher levels of stress and depression to prevent comorbidities. And for people who posted content, more attention should be paid when they have a higher level of negative affect.

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**Keywords** Media engagement; Anxiety; COVID-19; Network analysis.

## INTRODUCTION

At the beginning of 2020, the disease caused by a novel coronavirus spread rapidly around the world. To control the spread of COVID-19, people were asked to stay at home and keep distance from others. Even so, as shown in the real-time data of John Hopkins University, by January 18, 2022, there were over 330 million confirmed cases globally.

Since the beginning of this outbreak, the Chinese government has provided daily updates about surveillance and confirmed cases on websites and social media to emphasize the need for prevention.<sup>1</sup> A survey conducted by the Chinese Academy of Social Science showed that many people in China spent a lot of time searching and reading COVID-19-related media content per day.<sup>2</sup> Social media is a group of Internet-based applications that allow the creation and exchange of user-generated content.<sup>3</sup> And social media engagement usually represents users' interactions with the content, including views, likes, comments, shares, and postings.<sup>4</sup> But a high level of disaster-related media engagement would cause public panic and mental health problems.<sup>5</sup>

According to the conservation of resources theory, individuals' awareness of the loss of valued entities (such as objects, personal characteristics, conditions, and energies) would lead

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✉ **Correspondence:** Tour Liu, PhD

Faculty of Psychology, Tianjin Normal University, No.393 Binshui West Road, Xiqing District, Tianjin 300387, China

**E-mail:** mikebonita@hotmail.com

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to negative psychological outcomes.<sup>6</sup> A previous experiment had proved that exposure to a video clip depicting terror attacks could increase individuals' levels of the perceived threat and negative affect.<sup>7</sup> As for the current COVID-19 pandemic, it is a threat to all the people around the world. And media content of this life-threatening event makes people think about their inevitable death,<sup>8</sup> thus leading to feelings of helplessness and lowering one's sense of meaning in life and satisfaction with life.<sup>7</sup>

Previous empirical studies had found that viewing negative disaster-related content was associated with negative psychological outcomes, such as increases of depression,<sup>9</sup> anxiety,<sup>10</sup> stress,<sup>11</sup> and death anxiety.<sup>12</sup> And people who frequently reading COVID-19-related media content had more COVID-19-related anxiety symptoms than those who had less media exposure.<sup>13</sup> However, some recent studies found that compared with negative content, positive ones have opposite results. Content like hero acts and information about the disaster itself was associated with increases of positive affect<sup>14</sup> and lower odds of post-traumatic stress disorder.<sup>15</sup>

Generally, postings and views are two kinds of media engagement. Views are private engagement by viewing social media posts or videos, while postings are spreading content through public sharing into public networks or platforms.<sup>4</sup> Therefore, they are two completely distinct kinds of behaviors. However, previous studies mostly focused on exploring relationships between viewing the disaster-related media content and psychological outcomes, while ignoring the associations between posting behaviors and psychological outcomes. For example, LaRose et al.<sup>16</sup> indicated that individuals having higher levels of negative affect and stress would relieve these negative experiences by using social media. And according to the uses-and-gratifications theory, people have specific needs to be satisfied when using social media.<sup>17</sup> During the lockdown and home quarantine, their need may be social interactions. Therefore, it is conceivable that people could maintain social interactions with others by posting COVID-19-related content on their social media.<sup>18</sup> And these would increase support from their friends, which was good for mental health.<sup>19</sup> While people who did not post content on their social media did not take this advantage. Thus, the hypothesis of the present study was that people who posted COVID-19-related content would have fewer negative experiences than people who did not.

Furthermore, although many studies have already been conducted to determine whether different levels of disaster-related media engagement had different impacts on psychological outcomes, they only detected a few psychological outcomes at one time.<sup>5,13</sup> For example, a survey aimed to find out whether there were differences in anxiety and depression between the participants who had higher media engagement and those who had lower one by using logistic regression analyses.<sup>20</sup> Due to

the limitation of traditional analysis methods (e.g., t-tests and analysis of variances), the relationships among many (more than five) variables cannot be clarified clearly at one time.

As mentioned above, many kinds of psychological outcomes were associated with disaster-related media engagement. Network analysis is particularly useful for visualizing complex relationships between many variables.<sup>21,22</sup> Previously, researchers mostly focused on describing the characteristics of nodes and edges in a single network generated from a single population. For example, a prior study investigated 196 adults with bulimia nervosa (BN). And then a correlation network was generated from these adults' responses to identify the central symptoms of BN.<sup>23</sup> Recently, researchers' focuses have shifted to compare the structure of the networks generated from different subpopulations.<sup>24</sup>

Therefore, in the present study, first, participants were divided into two groups by their posting behaviors. Individuals who have posted COVID-19-related media content were in one group, and the remaining individuals without posting behaviors were in the other group. Then two networks were generated separately to examine the relationships between positive affect, negative affect, depression, anxiety, stress, satisfaction with life, death anxiety, and meaning in life. At last, network comparison tests were conducted to examine whether there were differences between those two networks.

## METHOD

### Procedure and participants

To control the spread of COVID-19, the public were asked to stay at home and keep distance from others by the Chinese government in January 2020. At this time, the present survey was conducted online (wj.qq.com). At first, the link of our questionnaire was shared in WeChat Moment by several teachers and students from Tianjin Normal University. People who saw the link were encouraged to complete the questionnaire and then share this link with others. Finally, the present study included 917 participants (304 males, 613 females), and the average age of them was 28.6 (standard deviation=9.5). All the participants had given consent for using their data in the study, and this study received ethical approval by the ethics committee of Tianjin Normal University (code: XL2020-12).

### Measures

The present survey consisted of six parts to examine participants' COVID-19-related posting behaviors and psychological outcomes. To fit the context of the COVID-19 outbreak, the questionnaires of media engagement, death anxiety, and meaning in life were adapted from previous studies. To verify these three adapted questionnaires, another two groups of par-

ticipants were recruited (one group consisted of 713 participants, and the other group consisted of 934 participants). The results of these empirical samples confirmed that these questionnaires were reliable and valid.

### Media engagement

One item was used to investigate whether the participants had ever posted any COVID-19-related content on their social media. The question only has two answers, one is “yes,” the other one is “no.”

### Positive and negative affect

The Positive Affect and Negative Affect Scale (PANAS) had two ten-item subscales for evaluating respondents’ positive affect and negative affect.<sup>25</sup> The present study utilized the Chinese version of PANAS,<sup>26</sup> which was confirmed to be reliable and valid in many other studies.<sup>27,28</sup> Items were rated on a five-point scale, from 1 (almost none) to 5 (extremely much). Higher scores indicate higher levels of positive affect or negative affect. The Cronbach’s alpha coefficients for each subscale in this study were as follows: positive, 0.84; and negative, 0.90.

### Depression, anxiety, and stress

The Chinese version of 21-item Depression Anxiety Stress Scale (DASS-21)<sup>29,30</sup> was used to measure individuals’ psychological distress. DASS-21 has three seven-item subscales for depression, anxiety, and stress. A four-point scale is used, ranging from 1 (never) to 4 (always). Higher scores indicate higher levels of psychological distress. The Cronbach’s alpha coefficients for each subscale in this study were as follows: depression, 0.82; anxiety, 0.78; and stress, 0.83.

### Satisfaction with life

The Satisfaction with Life Scale (SWLS) assessed respondents’ satisfaction with their own life.<sup>31</sup> The Chinese version of SWLS had five items, rated on a five-point scale of 1 (totally disagree) to 5 (totally agree).<sup>32</sup> With higher scores on this scale, individuals would be more satisfied with their own life. The Cronbach’s alpha coefficient for this questionnaire was 0.84.

### Death anxiety

The death anxiety questionnaire was composed of four revised items from the Chinese version of the death anxiety scale,<sup>33,34</sup> which were rated on a five-point scale of 1 (totally disagree) to 5 (totally agree). One example question is “I’m afraid of dying of COVID-19.” The higher scores on this questionnaire, the more concerned individuals were about their own safety. The Cronbach’s alpha coefficient for this questionnaire was 0.78.

The results of confirmatory factor analysis (CFA) based on

another group of 713 participants showed a good fit for one-factor model ( $\chi^2=2.77$ ,  $df=1$ , Comparative Fit Index [CFI]=0.998, Tucker-Lewis Index [TLI]=0.987, Root Mean Square Error of Approximation [RMSEA]=0.05, Standardized Root Mean Square Residual [SRMR]=0.01). And the Cronbach’s alpha coefficient was 0.79.

### Meaning in life

Four items were adapted from the Chinese version of the Meaning in Life Questionnaire<sup>35,36</sup> to fit the context of the COVID-19 outbreak. One example of these four items is “in the face of the severe outbreak, I still understand my life’s meaning” (more details in<sup>37,38</sup>). Each item was rated on a seven-point scale, from 1 (absolutely untrue) to 7 (absolutely true). Higher scores indicated individuals were more likely to create meaning in his or her own life. The Cronbach’s alpha coefficient for this questionnaire was 0.85.

In the other study of 934 participants, the result of CFA showed a good fit for one-factor model ( $\chi^2=10.29$ ,  $df=2$ , CFI=0.997, TLI=0.990, RMSEA=0.07, SRMR=0.01). And the Cronbach’s alpha coefficient was 0.91.

## Data analysis

### Data preprocessing and general differences

Firstly, 20 participants were excluded from further analyses because they have missing values or they all chose one value throughout one scale or more than one entire scales. Consequently, the final sample of this study consisted of 917 participants.

Secondly, all the participants were separated into two groups based on their answers to the media engagement question. People who had posted COVID-19-related content on their social media were called “Post group,” the others were named after “not post (Npost).”

Thirdly, the differences between these two groups in psychological outcomes were tested by using independent sample t-tests and bootstrap analyses (bootstrap=5,000) in IBM SPSS 25.0 (IBM Corp., Armonk, NY, USA).

### Correlation network analysis

In the current study, estimateNetwork function from the bootnet package (version 1.5) for R (version 4.0.5) was used to generate correlation networks,<sup>39</sup> and the qgraph function in the qgraph package (version 1.6.9)<sup>40</sup> was utilized to visualize these networks. An edge in a correlation network usually represents the correlation or partial correlation relationship between two variables. In an unregularized network, the weight of an edge was equal to the correlation coefficients between these two nodes connected by the focal edge.

The present study removed spurious partial correlation relationships (i.e., only displaying strong partial correlations in the correlation network) by using Graphic Least Absolute Shrinkage and Selection Operator.<sup>41</sup> All the edges which were not shrunk to zero remained in the networks.

To generate an appropriate sparse network, it is critical to select a good value for the tuning parameter ( $\lambda$ ). In qgraph package,  $\lambda$  can be obtained automatically by using the extended Bayesian information criterion (EBIC). But EBIC involves a hyperparameter ( $\gamma$ ) which controls the impact of the shrinkage penalty.<sup>42</sup> The present study set  $\gamma$  to be 0.5, according to previous research.<sup>43,44</sup> Besides, since participants had already been divided into two groups, two networks were generated separately.

The centrality indices make correlation network analysis provide a unique way to depict the relationships between the focal variable (i.e., node) and others. There are three most used centrality indices, which are strength centrality, betweenness centrality, and closeness centrality. Strength centrality is the sum of weights connected to the given node. Betweenness centrality indicates the number of times the given node is on the shortest path between two other nodes. Closeness centrality is the inverse total length of the shortest path from the given node to all other nodes.<sup>45-47</sup> In general, the higher these centrality indices a node has, the more central it is in the network. That is, a node with higher centrality indices indicates that the variable represented by this node is closely connected with other variables.

Moreover, the stability of node centrality was examined by bootnet function and corStability function (cor argument set to be 0.6) from the bootnet package based on the case-dropping bootstrap.<sup>48</sup> The CS-coefficient quantifies how susceptible correlation networks are to sampling variation. The previous research suggested that the CS-coefficient should not be below 0.25 and preferably above 0.50.<sup>48</sup> In the present study, the number of bootstraps was set to be 10,000. The accuracy of the edge-estimates was also examined by bootnet function but based on the nonparametric bootstrap analysis (bootstrap=10,000).<sup>48</sup>

**Network structure comparisons**

The NCT argument in NetworkComparisonTest package (version 2.2.1)<sup>49</sup> for R provided a way to compare differences between two networks based on a two-tailed permutation test. In the present study, 100,000 permutations were performed for randomly regroup participants.

Firstly, differences in overall connectivity between these two networks were tested. The overall connectivity (or global strength) is the weighted absolute sum of all edges in the network.<sup>42</sup> In this test, the significant difference indicated that one

network could be denser than the other one. However, the results could not reveal which edges were different.

Then, edge strength invariance and node centrality invariance were tested. In this step, each edge and node were tested individually. Since the present study had no prior hypotheses about differences in specific edges and nodes, the current analyses were exploratory. And as suggested by previous research, the present study tested all the edges and nodes without applying a correction for multiple comparisons.<sup>42,50</sup>

**Discrimination validity and common method bias test**

Confirmatory factor analyses were conducted in Mplus 8.3 (Muthén & Muthén, Los Angeles, CA, USA) to evaluate the discriminating validity between variables. Considering that sample-size-to-parameter ratio would affect the validity of model fit statistics, item parcels were formed.<sup>51</sup> For example, DASS-21 has three dimensions, so it was modeled using three parcels. And the results showed that the five-factor model provided a good fit, indicating these variables had good discrimination validity (Table 1).

Results of the Harman’s single factor test showed that there were 10 factors with eigenvalues greater than 1 and the first factor only accounted for 21.57% of the total variance, suggesting there was no serious common method variance in this study.

**RESULTS**

**General differences**

In the present sample, 474 participants had posted COVID-19-related content on their social media and 443 participants who never posted any COVID-19-related content. As shown in Table 2, the results indicated that Npost group had higher levels of negative affect, anxiety, stress, and death anxiety than Post group.

**Network structure comparisons**

The correlation networks of the Npost group and the Post group were shown in Figure 1. The results of the examination of the stability of node centrality showed that centrality indices

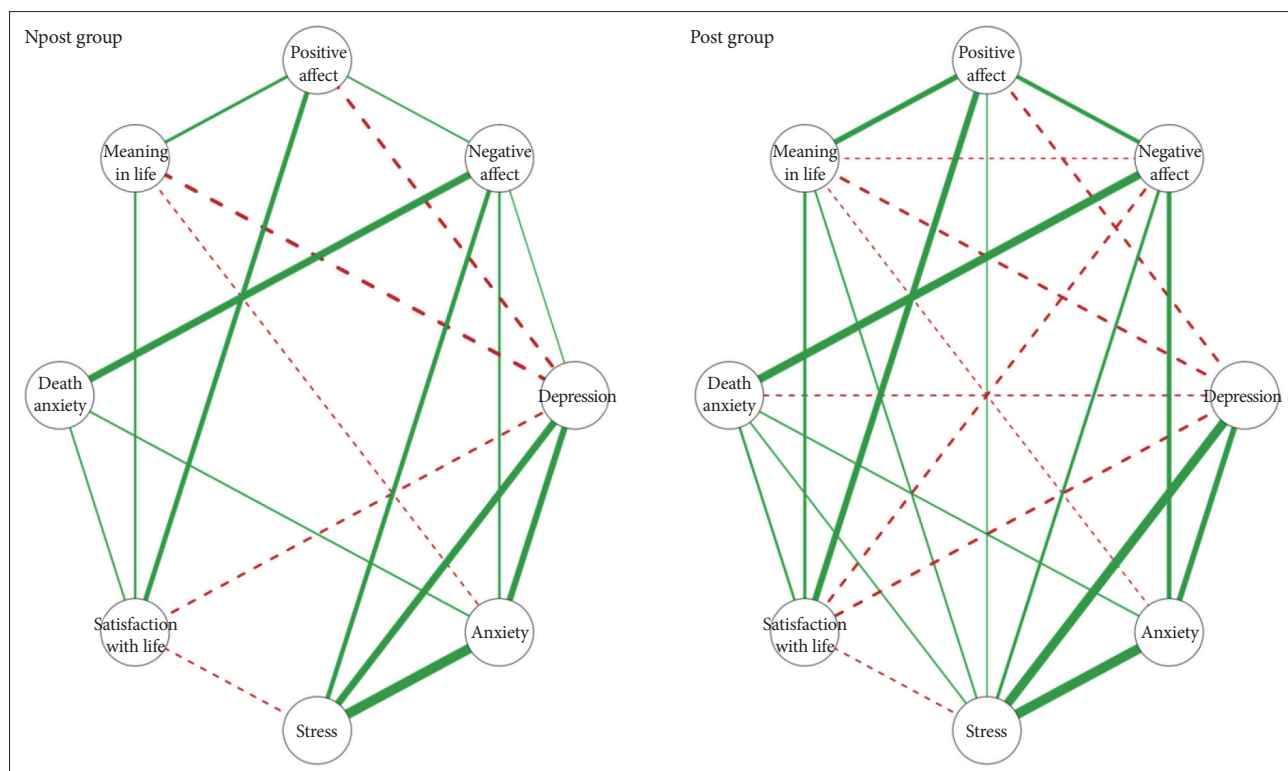
**Table 1.** Model fit statistics of the hypothesized five-factor model with other competing models (N=917)

Model	$\chi^2$ (df)	CFI	TLI	RMSEA	SRMR
One-factor	4,748.86 (135)	0.37	0.29	0.19	0.17
Two-factor	3,228.95 (134)	0.58	0.52	0.16	0.14
Three-factor	3,167.26 (132)	0.59	0.52	0.16	0.14
Four-factor	2,185.53 (129)	0.72	0.67	0.13	0.12
Five-factor	631.51 (125)	0.93	0.92	0.07	0.07

**Table 2.** Descriptive statistics and differences between two groups (N=917)

Variable	Npost group (N=443)	Post group (N=474)	t	p	Cohen's d	95% CI
Positive affect	28.81 (5.78)	28.38 (6.24)	1.07	0.284	-	-0.35–1.22
Negative affect	24.09 (7.13)	21.81 (7.53)	4.71	<0.001	0.31	1.33–3.22
Depression	10.83 (3.10)	10.72 (3.43)	0.49	0.621	-	-0.33–0.52
Anxiety	11.28 (2.88)	10.88 (3.13)	2.02	0.043	0.13	0.01–0.79
Stress	12.60 (3.31)	12.05 (3.56)	2.42	0.016	0.16	0.11–0.99
Satisfaction with life	14.17 (3.65)	14.57 (3.98)	-1.56	0.119	-	-0.87–0.10
Death anxiety	12.49 (3.68)	11.74 (3.84)	2.98	0.003	0.20	0.26–1.21
Meaning in life	21.48 (4.22)	21.39 (4.55)	0.33	0.743	-	-0.47–0.67

Data are presented as mean (standard deviation). CI, confidence interval



**Figure 1.** Correlation networks of the Npost group and the Post group. Solid green (dotted red) edges indicate positive (negative) correlations. Thicker edges represent stronger edges. See the digital version of the paper for the color version of this figure.

( $CS_{Strength\_Post}=0.75$ ,  $CS_{Betweenness\_Post}=0.28$ ,  $CS_{Closeness\_Post}=0.26$ ;  $CS_{Strength\_Npost}=0.75$ ,  $CS_{Betweenness\_Npost}=0.28$ ,  $CS_{Closeness\_Npost}=0.67$ ) of the networks were stable under subsetting cases. The results of the examination of the accuracy of the edge-estimates was shown in the Supplementary Figures 1 and 2 (in the online-only Data Supplement) following the reporting standards for psychological network analyses.<sup>39,52</sup> The results showed that most edges were significantly different from zero with relatively narrow confidence intervals. In sum, the present correlation networks were stable and accurate.

Visual inspections of Figure 1 revealed that Post group seemed to have a denser network than Npost group. And there are six

edges of Post group's network that were absent in Npost group's network, including positive affect–stress, negative affect–meaning in life, negative affect–satisfaction with life, depression–death anxiety, stress–meaning in life, and stress–death anxiety. Besides, there was a positive edge between negative affect and depression in Npost group's network, but no such edge in Post group's network. Since these interpretations only came from visual inspections, network comparison tests were conducted to provide some statistical supports.

Firstly, the overall connectivity invariance was tested. Results showed that the overall connectivity of Post group's network is significantly higher than that of Npost group's network

( $S_{\text{Post group}}=3.58$ ,  $S_{\text{Npost group}}=2.79$ ,  $p=0.016$ ). However, these results could not reveal which edges were different.

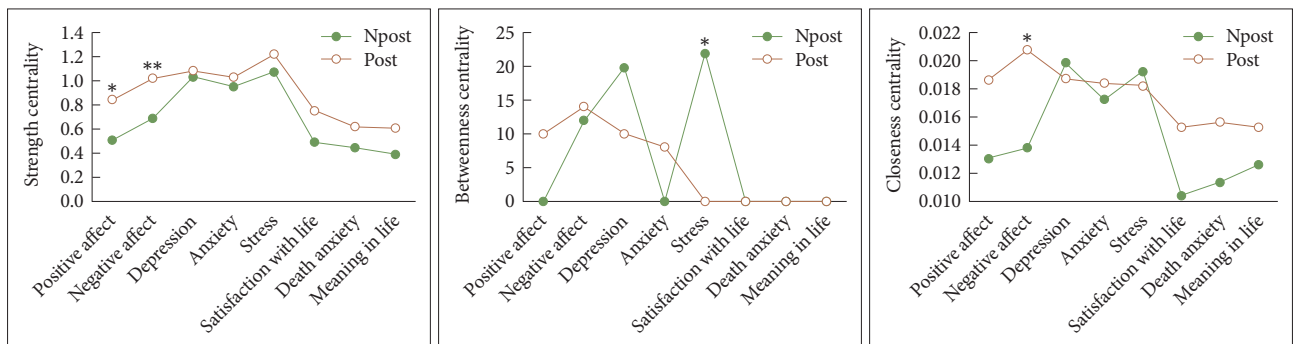
Consequently, edge strength invariance tests were conducted. Results showed that two edges differed significantly. As shown in Figure 2, these two edges were meaning in life–positive affect ( $E=-0.14$ ,  $p=0.031$ ) and negative affect–anxiety ( $E=-0.12$ ,  $p=0.045$ ). That is, the correlation between positive affect and meaning in life in Post group’s network was stronger than that in the Npost group’s network. So did the correlation between negative affect and anxiety.

Finally, to get more details about differences in local connectivity, the present study compared these two networks on three node centrality measures, including strength centrality, betweenness centrality, and closeness centrality (Figure 3). Regarding strength centrality, both networks had a similar pattern. The difference tests showed that positive affect ( $p=0.016$ )

and negative affect ( $p=0.008$ ) had significantly higher values in the Post group’s network than in the Npost group’s network. As for betweenness centrality, these two networks differed quite a lot from each other. In the Npost group’s network, stress had the highest value, and it was significantly higher than that of the Post group’s network ( $p=0.044$ ). While in the Npost group’s network, negative affect had the highest betweenness centrality. Considering closeness centrality, there were also great differences between the two networks. In the Npost group’s network, depression had the highest value. But in the Post group’s network, negative affect had the highest closeness centrality, and it was significantly higher than that of the Npost group’s network. These results indicated that these two networks had different central nodes. In the Npost group’s network, the central node was negative affect. While in the Post group’s network, stress and depression were in the center.



**Figure 2.** Edges which differ significantly between the Npost group’s network and the Post group’s network. A dotted red (solid green) edge indicates the edge has a higher value in the Post (Npost) group’s network.



**Figure 3.** Centrality indices of each node in the Npost group’s network and the Post group’s network. Symbol\* (\*\*) represents the node centrality invariance test is significant at the level of  $\alpha=0.05$  ( $\alpha=0.01$ ). See the digital version of the paper for the color version of this figure.

## DISCUSSION

Firstly, results of independent t-tests indicated that the Post group had lower levels of negative affect, anxiety, stress, and death anxiety. Then, the present study generated two networks for the Npost group and the Post group to depict the relationships between positive affect, negative affect, depression, anxiety, stress, satisfaction with life, death anxiety, and meaning in life. And network comparison tests were conducted to compare the differences between these two networks. Results showed that these two networks differed in global strength, two edges (meaning in life–positive affect and negative affect–anxiety), and node centrality indices. In the Npost group's network, stress and depression were central nodes, while in the Post group's network, negative affect was the central one.

The present study found that people who posted COVID-19-related content on their social media had lower levels of negative affect, anxiety, stress, and death anxiety. Being involved in a pandemic would certainly lead to negative psychological outcome,<sup>1,6</sup> but individuals tended to relieve these negative feelings by using social media.<sup>16</sup> Previous research suggested that active social media use such as posting content was different from negative social media use which was just scrolling through news feeds or browsing photographs of friends. And results showed that active social media use could decrease negative experiences such as fatigue.<sup>53</sup> Additionally, although the difference in depression symptoms between these two groups was not significant, the mean score of the Post group was still lower than that of the Npost group. Besides, no significant differences were found in positive affect, satisfaction with life, and meaning in life between these two groups. One potential explanation was that during the lockdown or self-quarantine, people spent more time caring for family and their friends.<sup>54,55</sup> Thus, most of them felt more satisfied with their life.

In the Npost group's network, stress had the highest strength and betweenness centrality and the second-highest closeness centrality, indicating that it was the central node. Consistent with other studies, the present study found stress, anxiety, depression, and negative affect were positively correlated with each other.<sup>14</sup> And stress was also negatively associated with satisfaction with life in the pandemic context in line with previous research under normal situations,<sup>56,57</sup> but this negative relationship was weak. Depression was also a central node, having the highest closeness centrality and the second-highest strength and betweenness centrality. And consistent with previous studies, it was negatively correlated with positive affect and meaning in life.<sup>14,37,58</sup> Meaning in life is a psychological source for enhancing healthy coping,<sup>59</sup> and it had a strong correlation with more positive wellbeing.<sup>60</sup> Thus, in the disaster context, the higher level of meaning in life would negatively

correlate with depression and anxiety but positively correlate with satisfaction with life and positive affect. While anxiety had the lowest betweenness centrality and the third-highest strength and closeness centrality. Lower betweenness centrality and higher strength and closeness centrality indicated that anxiety was not the only node close to many other nodes, and it was not on the shortest path between the other nodes. That meant anxiety was not the central node of this network despite its higher strength and closeness centrality. And satisfaction with life, death anxiety, meaning in life, and positive affect had lower centrality indices, having fewer associations with other variables.

Compared with the Npost group's network, negative affect had significantly higher closeness centrality in the Post group's network. And it was the central node of the Post group's network, having the highest betweenness and closeness centrality. Similar to the Npost group's network, negative affect was related to anxiety and death anxiety in the Post group's network. Surprisingly, it had a positive association with positive affect. Generally, people would think negative and positive affect naturally negatively correlated with each other. But indeed, these are two independent processes.<sup>61,62</sup> And the previous study had found that COVID-19-related media exposure was associated with increases of both negative and positive affect.<sup>14</sup> Stress had the highest strength centrality in the Post group's network, but lowest betweenness centrality, indicating it lay on no shortest path between other variables. This was different from the Npost group's network, where stress was the central node. But like the Npost group's network, in the Post group's network, satisfaction with life, death anxiety, and meaning in life were still at the edge. Furthermore, because the Post group's network had higher global strength, each node in the Post group's network had a higher strength centrality than that in the Npost group's network. Especially for positive and negative affect, they were significant at the levels of  $\alpha=0.05$  and  $\alpha=0.01$ . The potential explanation for this significant result may be that the weight of meaning in life–positive affect and negative affect–anxiety in the Post group's network is significantly larger than that in the Npost group's network.

There were still some limitations in the present study. First, this study was a cross-sectional design, so no causal relationship could be revealed. Although time-series data can be analyzed by using multilevel vector autoregressive time-series models to examine potential causal associations,<sup>63</sup> data collection for this analysis method is very difficult.<sup>53,64</sup> Besides, network comparison tests are not developed for this kind of network. Secondly, the participants were not chosen at random, so the parameters of interest may vary from one sample to another.<sup>65</sup> And all the participants were from China, the generalization of conclusion for residents in other countries is still

unexplored. Finally, some other psychological factors were also proved to be associated with the COVID-19 outbreak, but all these studies were published after the beginning of the survey, such as fear of COVID-19<sup>66</sup> and intolerance of uncertainty.<sup>65</sup> So, these factors were not taken into consideration in the present study.

Nevertheless, the results of the present study indicated that the posting behavior on social media was related to decreases of negative affect, anxiety, stress, and death anxiety. And two networks for the Npost group and the Post group had different central nodes. The central nodes were stress and depression, for Npost network, while negative affect instead for Post network. Therefore, for individuals who posted COVID-19-related content on social media, more attention should be paid when having a higher level of negative affect to prevent comorbidities. While for individuals who did not post this content, pay attention to higher levels of stress and depression.

### Supplementary Materials

The online-only Data Supplement is available with this article at <https://doi.org/10.30773/pi.2022.0146>.

### Availability of Data and Material

Data and code can be made available upon reasonable request to the corresponding author.

### Conflicts of Interest

The authors have no potential conflicts of interest to disclose.

### Author Contributions

Conceptualization: Tour Liu, Miao Chao. Data curation: Tour Liu. Formal analysis: Shu Zhang. Funding acquisition: Tour Liu. Investigation: Yanwen Zhang, Dini Xue, Huan Zhang, Miao Chao, Tour Liu. Methodology: Tour Liu, Shu Zhang. Project administration: Tour Liu. Resources: Tour Liu, Miao Chao, Huan Zhang, Dini Xue, Yanwen Zhang. Software: Shu Zhang. Supervision: Tour Liu. Validation: Shu Zhang. Visualization: Shu Zhang. Writing—original draft: Shu Zhang. Writing—review & editing: Shu Zhang, Yanwen Zhang, Dini Xue, Tour Liu.

### ORCID iDs

Shu Zhang <https://orcid.org/0000-0002-0614-3550>  
 Yanwen Zhang <https://orcid.org/0000-0001-6682-3729>  
 Dini Xue <https://orcid.org/0000-0001-8970-3324>  
 Huan Zhang <https://orcid.org/0000-0001-7988-0589>  
 Miao Chao <https://orcid.org/0000-0002-6286-5857>  
 Tour Liu <https://orcid.org/0000-0002-1186-2357>

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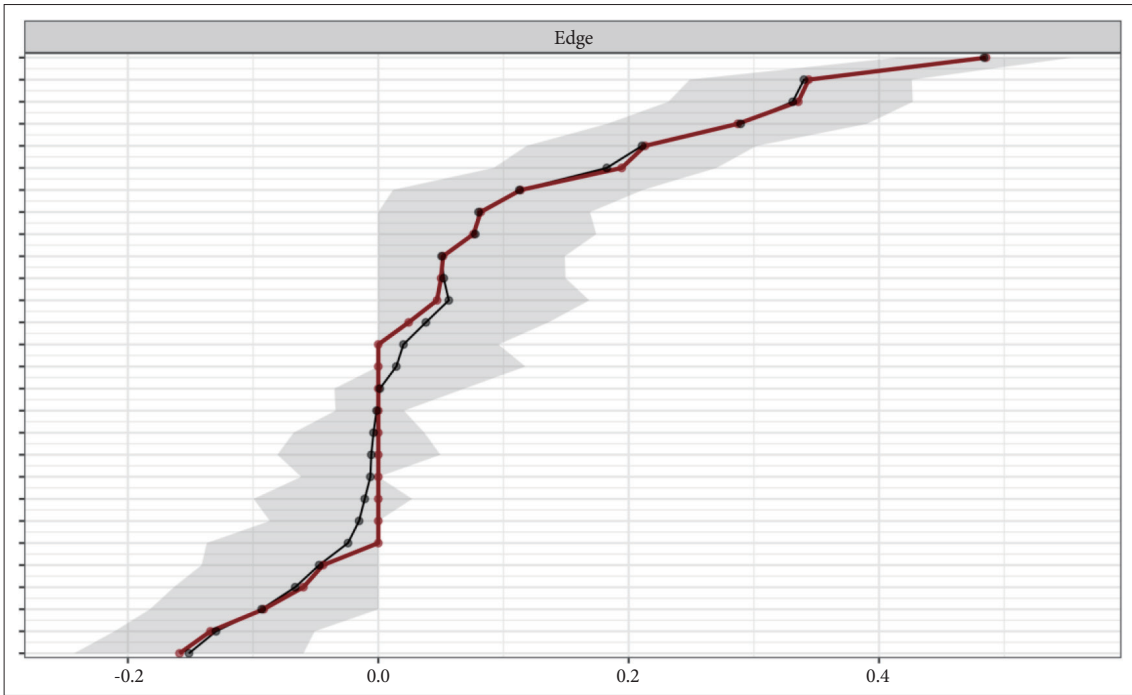
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### REFERENCES

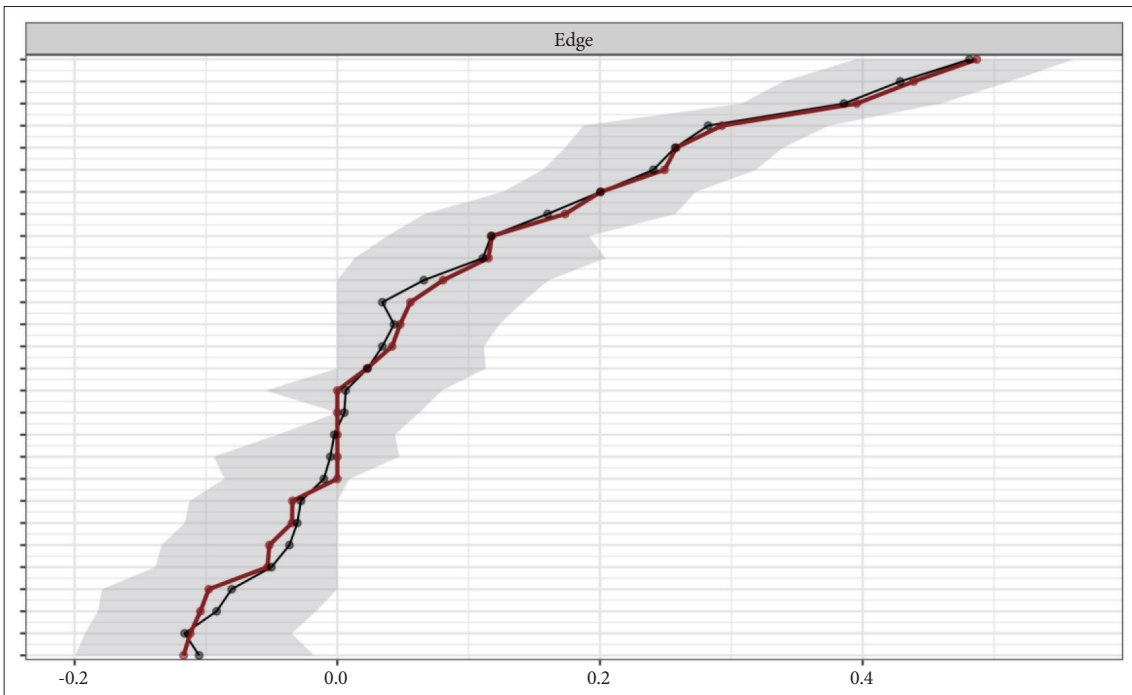
- Bao Y, Sun Y, Meng S, Shi J, Lu L. 2019-nCoV epidemic: address mental health care to empower society. *Lancet* 2020;395:e37-e38.
- Wang J, Gao W, Chen M, Ying X, Tan X, Liu X. A survey on psychological status of the public during the COVID-19 outbreak in China. Available at: [https://mp.weixin.qq.com/s/KH7Hfx-NnJQcJwWw\\_jc\\_IJA](https://mp.weixin.qq.com/s/KH7Hfx-NnJQcJwWw_jc_IJA). Accessed March 17, 2020.
- Kaplan AM, Haenlein M. Users of the world, unite! The challenges and opportunities of social media. *Bus Horiz* 2010;53:59-68.
- Aldous KK, An J, Jansen BJ. View, like, comment, post: analyzing user engagement by topic at 4 levels across 5 social media platforms for 53 news organizations. *Proceedings of the International AAAI Conference on Web and Social Media* 2019;13:47-57.
- Pfefferbaum B, Newman E, Nelson SD, Nitiéma P, Pfefferbaum RL, Rahman A. Disaster media coverage and psychological outcomes: descriptive findings in the extant research. *Curr Psychiatry Rep* 2014; 16:464.
- Hobfoll SE. Conservation of resources. A new attempt at conceptualizing stress. *Am Psychol* 1989;44:513-524.
- Zeidner M, Ben-Zur H, Reshef-Weil S. Vicarious life threat: an experimental test of conservation of resources (COR) theory. *Pers Individ Differ* 2011;50:641-645.
- Schrader MP, Wann DL. High-risk recreation: the relationship between participant characteristics and degree of involvement. *J Sport Behav* 1999;22:426-441.
- Busso DS, McLaughlin KA, Sheridan MA. Media exposure and sympathetic nervous system reactivity predict PTSD symptoms after the Boston marathon bombings. *Depress Anxiety* 2014;31:551-558.
- Ortiz CD, Silverman WK, Jaccard J, La Greca AM. Children's state anxiety in reaction to disaster media cues: a preliminary test of a multivariate model. *Psychol Trauma: Theory Res Pract Policy* 2011;3:157-164.
- Dougall AL, Hayward MC, Baum A. Media exposure to bioterrorism: stress and the anthrax attacks. *Psychiatry* 2005;68:28-42.
- Chen X, Liu T, Li P, Wei W, Chao M. The relationship between media involvement and death anxiety of self-quarantined people in the COVID-19 outbreak in China: the mediating roles of empathy and sympathy. *Omega (Westport)* 2022;85:974-989.
- Bendau A, Petzold MB, Pyrkosch L, Mascarell Maricic L, Betzler F, Roggoll J, et al. Associations between COVID-19 related media consumption and symptoms of anxiety, depression and COVID-19 related fear in the general population in Germany. *Eur Arch Psychiatry Clin Neurosci* 2021;271:283-291.
- Chao M, Xue D, Liu T, Yang H, Hall BJ. Media use and acute psychological outcomes during COVID-19 outbreak in China. *J Anxiety Disord* 2020;74:102248.
- Hall BJ, Xiong YX, Yip PSY, Lao CK, Shi W, Sou EKL, et al. The association between disaster exposure and media use on post-traumatic stress disorder following Typhoon Hato in Macao, China. *Eur J Psychotraumatol* 2019;10:1558709.
- LaRose R, Lin CA, Eastin MS. Unregulated Internet usage: addiction, habit, or deficient self-regulation? *Media Psychol* 2003;5:225-253.
- Rubin AM. Uses-and-gratifications perspective on media effects. In: Bryant J, Zillmann D, editors. *Media effects: advances in theory and research*. Mahwah, NJ: Lawrence Erlbaum Associates, 2002, p. 525-548.
- Guessoum SB, Lachal J, Radjack R, Carretier E, Minassian S, Benoit L, et al. Adolescent psychiatric disorders during the COVID-19 pandemic and lockdown. *Psychiatry Res* 2020;291:113264.
- Domènech-Abella J, Lara E, Rubio-Valera M, Olaya B, Moneta MV, Rico-Urbe LA, et al. Loneliness and depression in the elderly: the role of social network. *Soc Psychiatry Psychiatr Epidemiol* 2017;52:381-390.
- Gao J, Zheng P, Jia Y, Chen H, Mao Y, Chen S, et al. Mental health problems and social media exposure during COVID-19 outbreak. *PLoS One* 2020;15:e0231924.
- Liu D, Epskamp S, Isvoranu AM, Chen C, Liu W, Hong X. Network analysis of physical and psychiatric symptoms of hospital discharged patients infected with COVID-19. *J Affect Disord* 2021;294:707-713.
- Zhang S, Liu T, Liu X, Chao M. Network analysis of media exposure and psychological outcomes during the initial outbreak of COVID-19 in China. *Int J Ment Health Addict* 2022 Jan 23. [Epub]. Available at: <https://doi.org/10.1007/s11469-021-00738-1>.
- Levinson CA, Zerwas S, Calebs B, Forbush K, Kordy H, Watson H, et al. The core symptoms of bulimia nervosa, anxiety, and depression: a



- network analysis. *J Abnorm Psychol* 2017;126:340-354.
24. França AB, Trzesniak C, Schelini PW, Junior GHY, Vitorino LM. Exploring depressive symptoms among healthcare professionals and the general population during the COVID-19 pandemic in Brazil. *Psychol Rep* 2022;125:2416-2434.
  25. Watson D, Clark LA, Tellegen A. Development and validation of brief measures of positive and negative affect: the PANAS scales. *J Pers Soc Psychol* 1988;54:1063-1070.
  26. Weidong Z, Jing D, Schick CJ. The cross-cultural measurement of positive and negative affect examining the dimensionality of PANAS. *Psychological Science (China)* 2004;27:77-79.
  27. Liang Y, Zhu D. Subjective well-being of Chinese landless peasants in relatively developed regions: measurement using PANAS and SWLS. *Soc Indic Res* 2015;123:817-835.
  28. Liu T, Zhang S, Zhang H. Exposure to COVID-19-related media content and mental health during the initial outbreak of COVID-19 in China. *Scand J Psychol* 2022;63:283-289.
  29. Lovibond PF, Lovibond SH. The structure of negative emotional states: comparison of the depression anxiety stress scales (DASS) with the beck depression and anxiety inventories. *Behav Res Ther* 1995;33:335-343.
  30. Wang K, Shi HS, Geng FL, Zou LQ, Tan SP, Wang Y, et al. Cross-cultural validation of the depression anxiety stress scale-21 in China. *Psychol Assess* 2016;28:e88-e100.
  31. Diener E, Emmons RA, Larsen RJ, Griffin S. The satisfaction with life scale. *J Pers Assess* 1985;49:71-75.
  32. Yan B, Zheng X. Researches into relations among social-support, self-esteem and subjective well-being of college students. *Psychological Development and Education (China)* 2006;22:60-64.
  33. Templer DI. The construction and validation of a death anxiety scale. *J Gen Psychol* 1970;82:165-177.
  34. Yang H, Han L, Guo H. Study on the cross-cultural adjustment and application of the death anxiety scale. *Chinese Journal of Practical Nursing* 2012;28:53-57.
  35. Steger MF, Frazier P, Oishi S, Kaler M. The meaning in life questionnaire: assessing the presence of and search for meaning in life. *J Couns Psychol* 2006;53:80-93.
  36. Wang M, Dai X. Chinese meaning in life questionnaire revised in college students and its reliability and validity test. *Chin J Clin Psychol* 2008;16:459-461.
  37. Chao M, Chen X, Liu T, Yang H, Hall BJ. Psychological distress and state boredom during the COVID-19 outbreak in China: the role of meaning in life and media use. *Eur J Psychotraumatol* 2020;11:1769379.
  38. Xue D, Liu T, Chen X, Liu X, Chao M. Data on media use and mental health during the outbreak of COVID-19 in China. *Data Brief* 2021;35:106765.
  39. Epskamp S, Fried EI. A tutorial on regularized partial correlation networks. *Psychol Methods* 2018;23:617-634.
  40. Epskamp S, Cramer AO, Waldorp LJ, Schmittmann VD, Epskamp D. qgraph: network visualizations of relationships in psychometric data. *J Stat Softw* 2012;48:1-18.
  41. Jones PJ, Mair P, Riemann BC, Mugno BL, McNally RJ. A network perspective on comorbid depression in adolescents with obsessive-compulsive disorder. *J Anxiety Disord* 2018;53:1-8.
  42. van Borkulo CD, van Bork R, Boschloo L, Kossakowski JJ, Tio P, Schoevers RA, et al. Comparing network structures on three aspects: a permutation test. *Psychol Methods* 2022 Apr 11. [Epub]. Available at: <https://doi.org/10.1037/met0000476>.
  43. Chen J, Chen Z. Extended Bayesian information criteria for model selection with large model spaces. *Biometrika* 2008;95:759-771.
  44. Foygel R, Drton M. Extended Bayesian information criteria for Gaussian graphical models. In: Lafferty J, Williams C, Shawe-Taylor J, Zemel R, Culotta A, editors. *Advances in neural information processing systems 23 (NIPS 2010)*. Red Hook: NeurIPS, 2010, p. 2020-2028.
  45. Opsahl T, Agneessens F, Skvoretz J. Node centrality in weighted networks: generalizing degree and shortest paths. *Soc Netw* 2010;32:245-251.
  46. Zhang S, Liu T, Xia F, Li Y. A social network analysis approach to interpersonal relationship and mental health in college students. *Chin Ment Health J* 2020;34:855-859.
  47. Zhang S, Li Y, Ren S, Liu T. Associations between undergraduates' interpersonal relationships and mental health in perspective of social network analysis. *Curr Psychol* 2021 Mar 16. [Epub]. Available at: <https://doi.org/10.1007/s12144-021-01629-3>.
  48. Epskamp S, Borsboom D, Fried EI. Estimating psychological networks and their accuracy: a tutorial paper. *Behav Res Methods* 2018;50:195-212.
  49. van Borkulo C, Epskamp S, Jones PJ, Haslbeck J, Millner A. Network-ComparisonTest: Statistical comparison of two networks based on three invariance measures. 2019. 2.2.1 edn. R CRAN.
  50. Dalege J, Borsboom D, van Harreveld F, van der Maas HLJ. Network analysis on attitudes: a brief tutorial. *Soc Psychol Personal Sci* 2017; 8:528-537.
  51. Williams LJ, Vandenberg RJ, Edwards JR. Structural equation modeling in management research: a guide for improved analysis. *Acad Manag Ann* 2009;3:543-604.
  52. Burger J, Isvoranu AM, Lunansky G, Haslbeck JMB, Epskamp S, Hoekstra RHA, et al. Reporting standards for psychological network analyses in cross-sectional data. *Psychol Methods* 2022 Apr 11. [Epub]. Available at: <https://doi.org/10.1037/met0000471>.
  53. Aalbers G, McNally RJ, Heeren A, de Wit S, Fried EI. Social media and depression symptoms: a network perspective. *J Exp Psychol Gen* 2019; 148:1454-1462.
  54. Lau JT, Yang X, Tsui HY, Pang E, Wing YK. Positive mental health-related impacts of the SARS epidemic on the general public in Hong Kong and their associations with other negative impacts. *J Infect* 2006; 53:114-124.
  55. Zhang Y, Ma ZF. Impact of the COVID-19 pandemic on mental health and quality of life among local residents in Liaoning Province, China: a cross-sectional study. *Int J Environ Res Public Health* 2020;17:2381.
  56. Siddiqi FA, Azim ME, Babur MN, Osama M, Waheed A, Memon AR. Psychological stress and satisfaction with life among physical therapy students of Rawalpindi / Islamabad, Pakistan. *J Pak Med Assoc* 2019; 69:973-975.
  57. Smith MM, Saklofske DH, Yan G, Sherry SB. Does perfectionism predict depression, anxiety, stress, and life satisfaction after controlling for neuroticism? A study of Canadian and Chinese undergraduates. *J Individ Differ* 2017;38:63-70.
  58. Chow EO. The role of meaning in life: mediating the effects of perceived knowledge of stroke on depression and life satisfaction among stroke survivors. *Clin Rehabil* 2017;31:1664-1673.
  59. Steger MF, Kashdan TB, Sullivan BA, Lorentz D. Understanding the search for meaning in life: personality, cognitive style, and the dynamic between seeking and experiencing meaning. *J Pers* 2008;76:199-228.
  60. Alea N, Bluck S. When does meaning making predict subjective well-being? Examining young and older adults in two cultures. *Memory* 2013;21:44-63.
  61. Grzybowski SJ, Wyczesany M, Kaiser J. The influence of context on the processing of emotional and neutral adjectives--an ERP study. *Biol Psychol* 2014;99:137-149.
  62. Watson D, Tellegen A. Toward a consensual structure of mood. *Psychol Bull* 1985;98:219-235.
  63. Epskamp S, Waldorp LJ, Möttus R, Borsboom D. The Gaussian graphical model in cross-sectional and time-series data. *Multivariate Behav Res* 2018;53:453-480.
  64. Faelens L, Hoorelbeke K, Soenens B, Van Gaeveren K, De Marez L, De Raedt R, et al. Social media use and well-being: a prospective experience-sampling study. *Comput Hum Behav* 2021;114:106510.
  65. Di Blasi M, Gullo S, Mancinelli E, Freda MF, Esposito G, Gelo OCG, et al. Psychological distress associated with the COVID-19 lockdown: a two-wave network analysis. *J Affect Disord* 2021;284:18-26.
  66. Ahorsu DK, Lin CY, Imani V, Saffari M, Griffiths MD, Pakpour AH. The fear of COVID-19 scale: development and initial validation. *Int J Ment Health Addict* 2022;20:1537-1545.



Supplementary Figure 1. Bootstrapped confidence intervals of estimated edge-weights for the estimated network of the Npost group.



**Supplementary Figure 2.** Bootstrapped confidence intervals of estimated edge-weights for the estimated network of the Post group.