Addictive Behaviors 124 (2022) 107096

Contents lists available at ScienceDirect

Addictive Behaviors

journal homepage: www.elsevier.com/locate/addictbeh

# Gaming to cope: Applying network analysis to understand the relationship between posttraumatic stress symptoms and internet gaming disorder symptoms among disaster-exposed Chinese young adults

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A R T I C L E I N F O

*Keywords:*
Posttraumatic stress symptoms
Internet gaming disorder
Network analysis
Disaster
Typhoon

A B S T R A C T

Research has demonstrated that posttraumatic stress disorder (PTSD) is associated with internet-related problematic behaviors. However, studies have not explored the linkage between PTSD symptoms and internet gaming disorder (IGD) symptoms. The current study aimed to investigate the relationship between posttraumatic stress symptoms (PTSS) and IGD symptoms via network analysis. We conducted a cross-sectional study with 341 Chinese young adults directly exposed to a typhoon and examined the network structure of PTSS and IGD symptoms, along with bridge symptoms, to elucidate how they co-occur. Results indicated that 'avoiding external reminders' and 'anhedonia' were identified as the most central symptoms in the PTSD network, whereas 'preoccupation,' 'gaming despite harms', and 'loss of control' ranked highest on centrality in the IGD network. Two bridge symptoms emerged within the combined PTSD and IGD network model: 'concentration difficulties' and 'conflict due to gaming' from among the PTSS and IGD symptoms, respectively. These findings reveal novel associations between PTSS and IGD symptoms and provide an empirically-based hypothesis for how these two disorders may co-occur among individuals exposed to natural disasters.

## 1. Introduction

Posttraumatic stress disorder (PTSD) is a serious mental disorder characterized by the development of a set of symptoms following exposure to traumatic events (American Psychiatric Association, 2013). PTSD has been found among individuals exposed to disasters (Hall et al., 2015; Xu et al., 2018), with serious illnesses (Moschopoulou et al., 2018; Swartzman et al., 2017), repeatedly exposed to aversive details of stressful events (Chopko et al., 2018; Schuster & Dwyer, 2020), and who have lost loved ones (Eisma et al., 2019; Malgaroli et al., 2018). The estimated prevalence of PTSD among disaster victims is between 5.1% and 90% (Goenjian et al., 2001; Hall et al., 2019; Salehi et al., 2021). Untreated post-traumatic stress symptoms (PTSS) result in deleterious consequences and severe functional and emotional impairments for both patients and society (Stein et al., 2003). For example, PTSS leads to psychological distress (Horesh et al., 2017; Yuan, Shi et al., 2021), substance abuse (Flanagan et al., 2016; Norman et al., 2018), and excessive internet/smartphone use (Contractor et al., 2017, 2019; Evren et al., 2019).

Individuals suffering from PTSS are known to engage in a range of coping strategies. One common (though maladaptive) coping strategy is avoidance, whereby survivors make an effort to avoid thoughts and potential stressors (Friedman et al., 2014). Avoidance strategies can include engaging in behaviors that numb or distract, such as addictive behaviors. Therefore, it is not surprising that PTSS and addictive behaviors commonly co-occur among disaster-exposed individuals (McCauley et al., 2012).

Prior meta-analyses demonstrated that PTSS are strongly related to

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https://doi.org/10.1016/j.addbeh.2021.107096
Received 4 June 2021; Received in revised form 21 August 2021; Accepted 22 August 2021
Available online 24 August 2021
0306-4603/

addictive behavioral-problem syndromes (Pericot-Valverde et al., 2018; Thege et al., 2017; Torchalla et al., 2012). Recently, there has been growing recognition of the vital links between psychopathological symptom severity and internet gaming disorder (IGD), an internet-related problematic behavior and disorder in ICD-11, with an estimated prevalence around 2.0% among young adults (e.g., Chiu et al., 2018; Stevens et al., 2020; Wartberg et al., 2017). Gaming Disorder, including online and offline gaming, was recently included as an official diagnosis in the ICD-11 of the World Health Organization (WHO, 2018) underlining the importance to study individual differences in tendencies towards Gaming Disorder; however, it is also important to refrain from over-pathologizing everyday life behaviors (Billieux, Schimmenti, Khazaal, Maurage, & Heeren, 2015).

Video games provide an escape from negative feelings for distressed people who avoid being exposed to stressful or traumatic cues (King & Delfabbro, 2019). This is especially true among youth who have more free time to use digital devices, and who may be prone to play video games for stress relief, having fun, and socializing with others (Yuan, Elhai et al., 2021). However, some individuals who engage in problematic gaming behaviors, specifically those who are unable to self-regulate their gaming, are considered to have IGD symptoms (King & Delfabbro, 2019). Studies have found a robust relationship between mental disorders and IGD symptoms (Teng et al., 2021; Wartberg et al., 2019; Yuan, Elhai et al., 2021). There is also increasing evidence that PTSS, in particular, are associated with excessive internet use (Hsieh et al., 2016; Lee et al., 2017; Yang et al., 2020), but IGD has not been examined in this regard. This suggests that PTSS might be related to IGD symptoms given the underlying similarity between different types of problematic internet behaviors (Montag, Wegmann, Sariyska, Demetrovics, & Brand, 2020; Montag, Wegmann, Sariyska, Demetrovics, & Brand, 2021).

Several theories provide conceptual explanations about how PTSS and IGD symptoms may be associated – especially the Interaction of Person-Affect-Cognition-Execution (I-PACE) model developed by Brand et al. (2016), Brand et al. (2019). This model presents a comprehensive theoretical framework that attempts to interpret possible mechanisms in the development of Internet usage disorder symptoms, which represent four main factors including *individual's core characteristics* (e.g., psychopathology, social cognitions, personality); *affective and cognitive responses to internal or external stimuli* (e.g., urge for mood regulation, attentional bias, craving); *executive and inhibitory control, and decision-making behavior resulting in internet usage*; and *consequences of gaming or another Internet applications* (Brand et al., 2016; Brand et al., 2019). According to I-PACE, when individuals with psychopathology (e.g., PTSS) confront internet use-related cues, they may experience exacerbations in stress and negative mood symptoms, which, in turn, might lead to possible reductions in executive function and inhibitory control. Consequently, they might search for a mood-relieving escape from reality and decide to immerse themselves in video games to gain pleasure from gratification and compensation experiences that result from playing (King & Delfabbro, 2019). This theoretical model has been empirically supported in research of IGD symptoms and other excessive internet/smartphone use behaviors (e.g., Elhai, McKay et al., 2020; Elhai, Yang et al., 2020; Yuan, Elhai et al., 2021).

The self-medication model proposes that disaster-exposed individuals with PTSS are at increased risk for addictive behaviors due to excessive usage of substances in order to deal with trauma-related symptoms (Khantzian, 1999). Consistent with substance use disorder, IGD could also be considered as a coping-oriented addictive disorder. According to the self-medication hypothesis, individuals using problematic strategies (such as IGD and substance abuse) to handle trauma-related negative emotions may experience temporary relief of adverse effects, which, in turn, negatively reinforces IGD symptoms or excessive technology use in similar situational and affective contexts, eventually resulting in more frequent and maladaptive use (Berenz et al., 2019).

The present study utilized a network analytical approach to explore relations between PTSS, relations between IGD symptoms, and their possible comorbidity. The network model framework has increasingly been applied in clinical psychology and psychopathology research (e.g., Duek et al., 2021; Garabiles et al., 2019; Li et al., 2020), which highlights the role of symptoms and the ways how they overlap (Borsboom & Cramer, 2013; Hofmann et al., 2016). According to the network perspective, psychopathology is the composition of symptoms related to dynamic and potential causal associations that may reinforce and interact with each other (Fried et al., 2017; Lazarov et al., 2020; McNally, 2016, 2017). Therefore, network analysis is a nuanced approach that allows researchers to closely illuminate possible relationships between symptoms of frequently comorbid disorders such as PTSD and IGD. Utilizing this approach, individuals' PTSS and IGD symptoms are signified by *nodes*, and the linkages between them are represented by *edges* that link pairs of nodes. *Strength centrality* can also be measured in the network model, indicating which nodes are the most important symptoms and have the strongest connections to other nodes within the model (Epskamp et al., 2018). Scholars have contended that confirming central symptoms within a network model is clinically meaningful in prioritizing symptoms to target in the treatment of mental disorders (Papini et al., 2020). In addition, *bridges* or *bridge nodes* can be clarified via network analysis, which are highly linked to nodes of another disorder (Cramer et al., 2010). Identifying these bridges may clarify the relationship between PTSD and IGD and, more importantly, provide new insights for researchers and clinicians related to preventing or alleviating comorbidity of PTSD with other addictive disorders.

To our knowledge, this is the first study to examine relationships among symptoms of PTSD and IGD among disaster-exposed adults using a network analytic approach. Using network analysis, the PTSS network, IGD symptom network, and combined network model with PTSS and IGD symptoms were estimated, respectively. The study also aimed to identify key bridge symptoms that connect the two disorders. Since network analysis is a largely exploratory technique to estimate key associations among symptoms and between symptom communities, no hypotheses were generated about specific symptoms that would emerge as central nodes and connectors within these network models. It should be noted that, in this cross-sectional study, the network models are statistically descriptive models, but may not necessarily explain the causal associations between nodes.

## 2. Method

### 2.1. Participants and procedure

Data for the current project came from a longitudinal research program on psychological health and adjustment among Chinese young adults after Typhoon Hato (Hall et al., 2019; Shi & Hall, 2020; Yuan, Shi et al., 2021). Typhoon Hato was one of the strongest environmental disasters to hit Macao, China, in >50 years. Hato made landfall on the city on August 23, 2017, caused 10 deaths and nearly 200 injuries and an estimated 1.42 billion dollars in damages (Hall et al., 2019). Participants were recruited from University of Macau in China. The entire campus was massively struck by Typhoon Hato, where water, food supplies, and electric power took several days to be restored (Hall et al., 2019). Data used in this study were collected on September 3rd, 2018, one year after the typhoon. 341 Chinese university students ($M_{age} = 21.24$, $SD = 2.72$) were enrolled in this research, of whom 258 (75.7%) were female.

Participants were recruited via announcements delivered through campus-wide emails and posters throughout campus. All participants were informed of the research aims and procedures and provided informed consent. An online survey including self-report questionnaires was distributed to all participants via email. A lottery with a cash prize of 100 Macau Patacas (approximately $13 USD) for 50 people was offered as an incentive for study participation. The Research Ethics Committee of the [BLINDED FOR PEER REVIEW] approved all research procedures.

### 2.2. Measures

#### 2.2.1. Ptss

Post-traumatic stress symptoms were evaluated by the PTSD Checklist for DSM-5 (PCL-5, Weathers et al., 2013), anchored to the past-month and specifically to the typhoon experiences. The PCL-5 consists of 20 items, which is a five-point scale with response options ranging from 0 (not at all) to 4 (extremely). Sample items include, “Feeling very upset when something reminded you of the typhoon Hato?”, “Blaming yourself or someone else strongly for the typhoon Hato or what happened after it”, and “Having strong negative feelings such as fear, horror, anger, guilt, or shame”. Higher total scale scores represented more severe levels of PTSS. The Chinese version of the PCL-5 has been validated in Chinese samples (Wang et al., 2015; Zhou et al., 2017). In this study, the questionnaire demonstrated excellent internal consistency (Cronbach’s α for global PTSS was 0.95, for Cluster B was 0.87, for Cluster C was 0.86, for Cluster D was 0.91, for Cluster E was 0.89).

#### 2.2.2. Igd

IGD symptoms were measured by the Chinese version of the Internet Gaming Disorder Questionnaire (Petry et al., 2014), anchored to the past year. The scale includes nine items, each rated on a dichotomous yes (“1″)/no (“0”) scale. Sample items include, “Have you experienced loss of interests in previous hobbies and entertainment as a result of, and with the exceptions of, Internet games?”, “Do you feel preoccupied with Internet games (think about previous gaming activity or anticipate playing the next game)?”, and “Have you jeopardized or lost a significant relationship, job, or educational or career opportunity because of participation in Internet games?”. Higher total scores represent greater IGD symptoms. In previous studies of Chinese samples, the IGD questionnaire showed good reliability and construct validity (Ding et al., 2018; Petry et al., 2014). In the present study, the scale demonstrated good internal consistency (Cronbach’s α was 0.82).

### 2.3. Data analysis

Univariate statistics for each node were analyzed via SPSS 23.0, including Pearson’s correlations and partial correlations of all study variables. Network models depicting the structure of PTSS and IGD symptoms and interactions between them were computed using R software (R Core Team, 2019). No missing data were evident because consenting participants were prompted to complete all items. Model variables were normally distributed based on results of Shapiro-Wilk tests and Kolmogorov-Smirnov tests (*ps* $> 0.05$); the highest skewness value (in absolute size) was 1.72 (IGD symptoms), and for kurtosis was 2.11 (PTSS). Independent samples t-tests were used to examine possible gender differences on study variables; no significant difference was observed for PTSS ($t = 1.583$, $p > 0.05$), while a significant difference on IGD symptoms was noted ($t = 2.561$, $p < 0.05$). The graphic LASSO (Least Absolute Shrinkage and Selection Operator) was used to compute regularized partial correlation networks (Epskamp et al., 2018). Visualization of the network models was provided by the *qgraph* package (Epskamp et al., 2012) and the *IsingFit* package (van Borkulo et al., 2014; van Borkulo et al., 2016). Expected influence (EI), a superior centrality index, was computed to assess the centrality of each node and identify which nodes were most influential in a network model (Robinaugh et al., 2016). According to Peters et al. (2021), we computed the regularized partial correlation networks for PTSS and IGD symptoms separately, and subsequently computed the combined network model to explore possible co-morbidity. The bridge expected influence (BEI; Jones et al., 2019) was computed with the *networktools* package (Jones, 2020) to identify which nodes could “bridge” PTSS and IGD symptom communities. Nodes with highest BEI values were considered bridge nodes in the combined network model. We utilized the *bootnet* package (Epskamp & Fried, 2020) with 1000 case-dropping bootstraps to estimate the stability of each network model via a correlation stability coefficient (*CS*-coefficient; Epskamp & Fried, 2018). The recommended cut-off for the *CS*-coefficient was set at 0.25 (Eskamp & Fried, 2018). The default value of $r = 0.7$ was used in the bootstrapping procedure.

## 3. Results

Table 1 provides descriptive statistics including the means, standard deviations, and the intercorrelations among study variables. Table 2 provides a description of node names for all PTSS and IGD symptoms included in the network analysis as well as the univariate statistics for each node.

### 3.1. PTSS network model

The network structure of PTSS and EI value for each node are shown in Fig. 1. The *CS*-coefficients for edge weights [$CS$ (cor = 0.7) = 0.56] and EI values [$CS$ (cor = 0.7) = 0.49] were acceptable, reflecting stability of the PTSS network model (Eskamp & Fried, 2018). *Avoidance of reminders* (C2) emerged as the most influential symptom in this regularized partial correlation network model, followed by *restricted affect* (D7). *Emotional cue reactivity* (B4) was the least central symptom. The strongest edges were *avoidance of thoughts* (C1)-to-*avoidance of reminders* (C2), *hypervigilance* (E3)-to-*exaggerated startle response* (E4), *difficulty concentrating* (E5)-to-*sleep disturbance* (E6), and *loss of interest* (D5)-to-*detachment* (D6). The standardized estimates of node strength, betweenness, closeness, and expected influence are presented in Fig. A.1. Boostrapped confidence intervals (CIs) of the edge weights are shown in Fig. A.2.

### 3.2. IGD network model

The network model of IGD symptoms and EI value for each node are depicted in Fig. 2. Edge weights of the IGD symptom network model, $CS$ (cor = 0.7) = 0.48, as well EI values, $CS$ (cor = 0.7) = 0.39 were stable. *Preoccupation*, *gaming despite harms*, and *loss of control* were the most central symptom nodes in the IGD network; conversely, *gaming for escape or mood relief* was the least central symptom. The strongest edges in the IGD network model emerged between *gaming despite harms* and *conflict due to gaming, loss of non-gaming interests* and *deception of others about gaming*, as well as *tolerance* and *loss of control*. The standardized estimates of node strength, betweenness, closeness, and expected influence are illustrated in Fig. A.3. Boostrapped confidence intervals (CIs) of the edge weights are presented in Fig. A.4.

### 3.3. Combined PTSS and IGD network model

The combined network model of PTSS and IGD symptoms is illustrated in Fig. 3. The combined model was stable as indicated by *CS*-coefficient for edge weights, $CS$ (cor = 0.7) = 0.65, and for BEI values, $CS$ (cor = 0.7) = 0.38. In the combined network model, *difficulty concentrating* (E5) and *conflict due to gaming* had the highest one-step BEI values and emerged as bridge nodes. The standardized estimates of node strength, betweenness, closeness, and expected influence are shown in Fig. A.5. Boostrapped confidence intervals (CIs) of the edge weights are depicted in Fig. A.6.

## 4. Discussion

The current study examined network models of PTSS, IGD, and their interaction among 341 Chinese university students one year after a severely destructive typhoon. To our knowledge, this is the first study, not only to investigate the network structure of PTSS and IGD symptoms, respectively, but also to explore the possible co-occurrence between PTSS and IGD symptoms and identify the bridge symptoms between these two mental disorders in a sample of disaster-exposed young adults.

Within the PTSS network model, avoidance of reminders (C2) and

**Table 1**
Means, standard deviations, and correlations among study variables.

| | M ± SD | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| 1. PTSS total | 5.45 ± 8.97 | – | 0.731*** | 0.664*** | 0.832*** | 0.836*** | 0.235*** |
| 2. PTSS Cluster B | 0.21 ± 0.78 | 0.739*** | – | 0.781*** | 0.656*** | 0.597*** | 0.127* |
| 3. PTSS Cluster C | 0.06 ± 0.28 | 0.676*** | 0.790*** | – | 0.667*** | 0.550*** | 0.075 |
| 4. PTSS Cluster D | 0.37 ± 1.19 | 0.838*** | 0.669*** | 0.681*** | – | 0.763*** | 0.174** |
| 5. PTSS Cluster E | 0.47 ± 1.17 | 0.839*** | 0.608*** | 0.563*** | 0.769*** | – | 0.230*** |
| 6. IGD symptoms | 1.30 ± 1.98 | 0.238*** | 0.137* | 0.087 | 0.181** | 0.234*** | – |

Note: Below the diagonal is the Pearson's correlations of all study variables, above the diagonal is the partial correlations of all the variables adjusted by age and gender. PTSS = posttraumatic stress symptoms, IGD = internet gaming disorder. ***$p < .001$, **$p < .01$, *$p < .05$.

**Table 2**
Descriptions and univariate statistics for network nodes.

| Node | Item content | *M* | *SD* |
|---|---|---|---|
| B1 | Intrusive thoughts | 0.35 | 0.65 |
| B2 | Nightmares | 0.08 | 0.34 |
| B3 | Flashbacks | 0.17 | 0.50 |
| B4 | Emotional cue reactivity | 0.36 | 0.64 |
| B5 | Physiological cue reactivity | 0.12 | 0.45 |
| C1 | Avoidance of thoughts | 0.14 | 0.45 |
| C2 | Avoidance of reminders | 0.13 | 0.45 |
| D1 | Trauma-related amnesia | 0.19 | 0.51 |
| D2 | Negative beliefs | 0.36 | 0.73 |
| D3 | Blame of self or others | 0.14 | 0.48 |
| D4 | Negative trauma-related emotions | 0.24 | 0.60 |
| D5 | Loss of interest | 0.28 | 0.62 |
| D6 | Detachment | 0.34 | 0.72 |
| D7 | Restricted affect | 0.29 | 0.69 |
| E1 | Irritability | 0.31 | 0.71 |
| E2 | Reckless behavior | 0.13 | 0.44 |
| E3 | Hypervigilance | 0.41 | 0.74 |
| E4 | Exaggerated startle response | 0.31 | 0.67 |
| E5 | Difficulty concentrating | 0.57 | 0.88 |
| E6 | Sleep disturbance | 0.54 | 0.89 |
| IGD1 | Preoccupation | 0.27 | 0.45 |
| IGD2 | Withdrawal | 0.14 | 0.35 |
| IGD3 | Tolerance | 0.13 | 0.34 |
| IGD4 | Loss of control | 0.09 | 0.28 |
| IGD5 | Loss of non-gaming interests | 0.10 | 0.30 |
| IGD6 | Gaming despite harms | 0.18 | 0.38 |
| IGD7 | Deception of others about gaming | 0.08 | 0.28 |
| IGD8 | Gaming for escape or mood relief | 0.26 | 0.44 |
| IGD9 | Conflict due to gaming | 0.05 | 0.22 |

restricted affect (D7) were identified as the two most central nodes, consistent with several previous PTSS networks (Benfer et al., 2018; Jiang et al., 2020; Mitchell et al., 2017; von Stockert et al., 2018). Four strong associations found in the present study have also been found in past research in other samples (Afzali et al., 2017; Armour et al., 2017; Benfer et al., 2018; Epskamp et al., 2018; Greene et al., 2018; Yuan, Park et al., 2021), including avoidance of thoughts (C1) and reminders (C2), hypervigilance (E3) and exaggerated startle response (E4), difficulty concentrating (E5) and sleep disturbance (E6), as well as loss of interest (D5) and detachment (D6). From a treatment perspective, these results suggest that exposure-based interventions (e.g., Thompson-Hollands et al., 2018; Langkaas et al., 2017) to reduce avoidance of feared cues and unexpressed emotions may be particularly important in reducing PTSS within this population.

Within the IGD symptoms network model, preoccupation emerged as the most influential symptom, which suggests that video game playing as the dominant activity in daily life is critical for the development and maintenance of IGD. One possible reason for the centrality of preoccupation is that the severity of absorption in gaming might decrease the availability of cognitive resources for non-gaming activities, contributing to failure of focusing on studying and working tasks or unsuccessful, inefficient interaction with others (King & Delfabbro, 2019). Gaming despite harms and loss of control also emerged as two highly central symptoms in the IGD network. It might represent that disaster-exposed people with IGD symptoms are prone to utilize video games as a temporary escape or distraction from negative trauma-related experiences or emotions (King & Delfabbro, 2014), despite awareness of psychosocial problems caused by continued excessive video game usage.

The three strongest edges in the IGD network model included (1) gaming despite harms and conflict due to gaming, (2) loss of nongaming interests and deception of others about gaming, and (3) tolerance and loss of control. First, individuals with IGD symptoms may have recognized their detrimental consequences due to problematic video game usage, but continued to play games nevertheless – even if they jeopardized or lost important relationships or critical opportunities due to gaming. Second, loss of interest in previous hobbies and entertainment might be symptomatic of overvaluing positive experiences of playing videogames; thus, other activities and personal relationships are considered less attractive (King & Delfabbro, 2014), an attitude that might feed indifference towards relationships with family members or friends as well as a lack of awareness of the amount of time devoted to gaming. Third, tolerance and loss of interest are two common indicators of impairment in decision-making abilities (West, 2001). Once individuals spend an ever-increasing amount of time engaged in gaming, to relieve negative emotions and/or reach desired goals, they have difficulty successfully controlling their excessive game playing (King & Delfabbro, 2014).

In the combined symptom network, we found two key bridge symptoms between PTSS and IGD, namely, difficulty concentrating (E5) and conflict due to gaming (IGD9). These findings suggest that difficulty concentrating from the PTSS cluster has a great influence on the development and maintenance of IGD symptoms, and that conflict due to gaming from the IGD cluster may be inconducive to the recovery from PTSS.

Trouble concentrating is one of the most prevalent symptoms among trauma survivors with PTSD symptoms (Holmes et al., 2017; Schnurr & Lunney, 2019). One possible hypothesis is that disaster-exposed individuals who have trouble concentrating on daily routines (e.g., working, studying, and entertainment) or a variety of disturbing thoughts and memories are more likely to seek a method to alleviate adverse feelings (Contractor et al., 2019). Internet games provide a valuable and portable tool for survivors to decrease pain caused by difficulty concentrating, which is consistent with I-PACE (Brand et al., 2016; Brand et al., 2019). This finding underscores the importance of considering the crucial effect of trouble concentrating when clinicians and educators attempt to treat traumatized college students' IGD symptoms or problematic internet use.

Conflict/interference due to gaming as the other key bridging symptom highlights how the individuals' relationships with significant others (i.e., parents, friends, teachers, and peers) and educational or career aspirations and opportunities may be jeopardized due to problematic gaming, with potential consequences that include losses or the absence of social support in daily life (King & Delfabbro, 2019). According to Schaefer and Moos's (1992) crises-growth model, a supportive social environment provides people with essential and required resources for dealing with trauma and a safe environment. These resources help decrease adverse psychological consequences of the trauma (Schaefer & Moos, 1998). Individuals with significant IGD symptoms

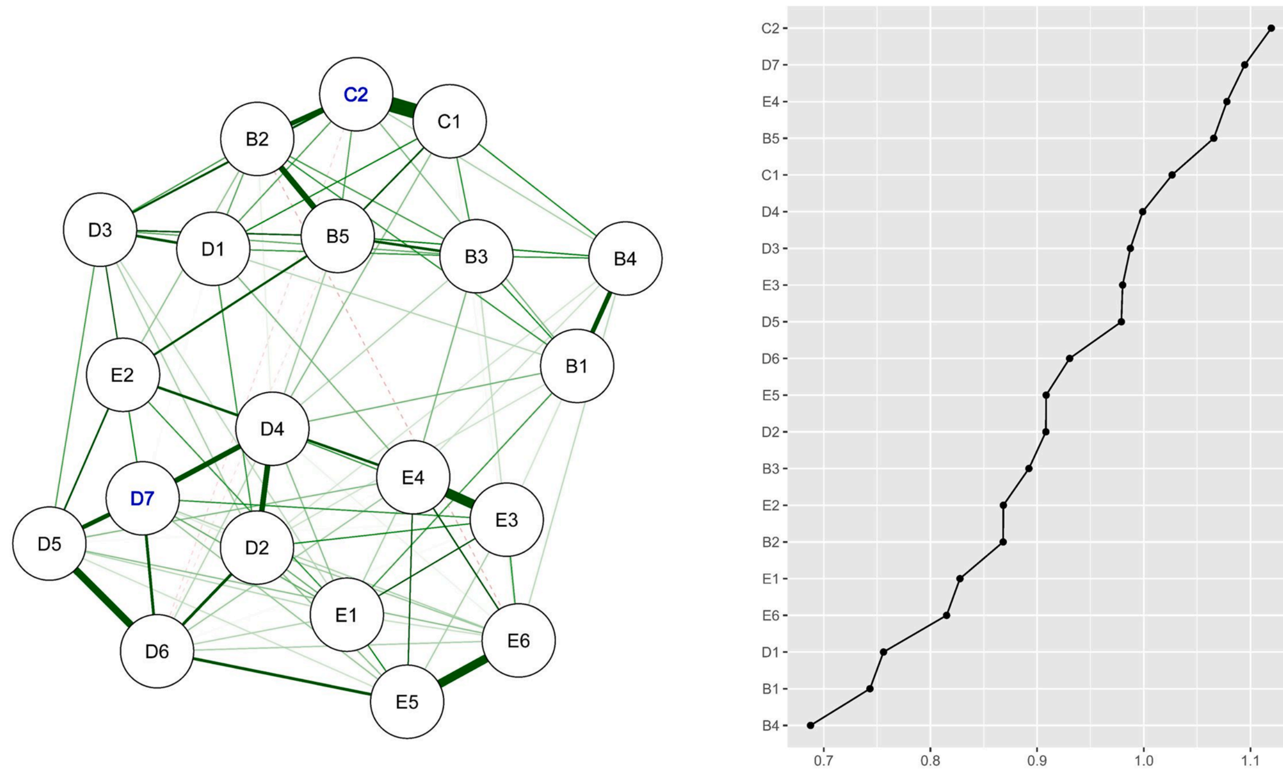


**Fig. 1.** Regularized partial correlation network model for posttraumatic stress symptoms (PTSS) and expected influence (EI) values for each node. Note: Nodes with large EI values are represented by blue text (C2 and D7). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

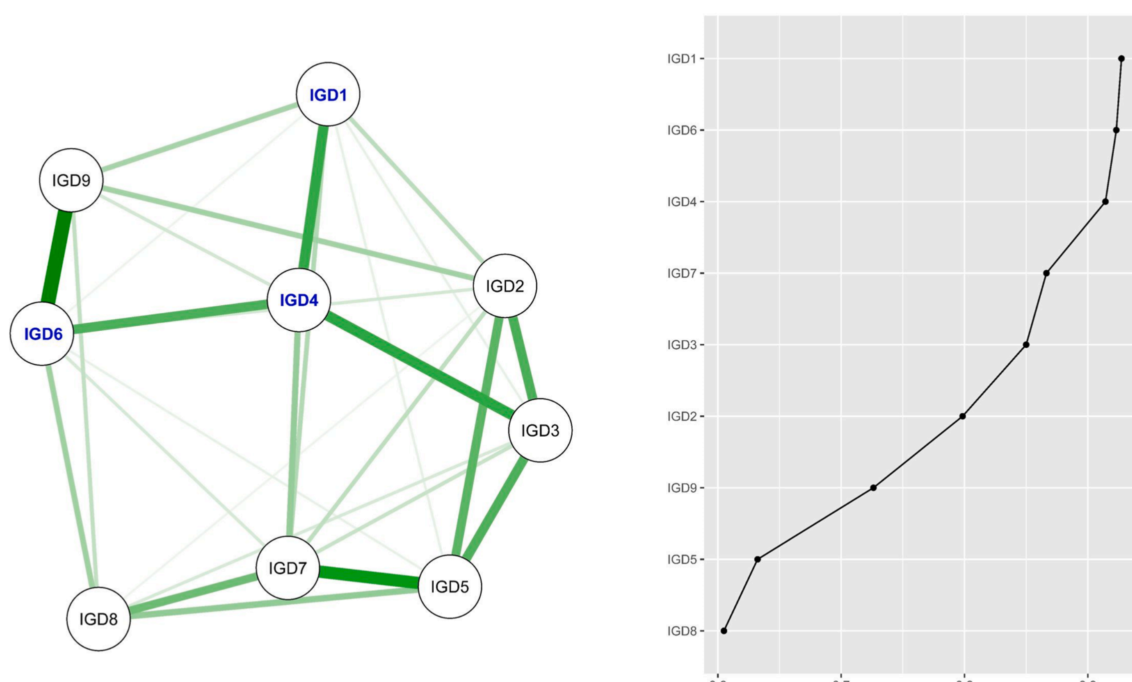


**Fig. 2.** Regularized partial correlation network model for internet gaming disorder (IGD) symptoms and expected influence (EI) values for each node. Note: Nodes with large EI values are represented by blue text (IGD1, IGD4, and IGD6). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

may excessively playing video games, and as a consequence, devote little time towards developing and maintaining supportive relationships, which in turn decreases social resources they receive from others and aggravates their PTSS (Dworkin et al., 2018; Yuan et al., 2018).

Several study limitations warrant consideration. First, although network analysis can be used to investigate potential temporal and

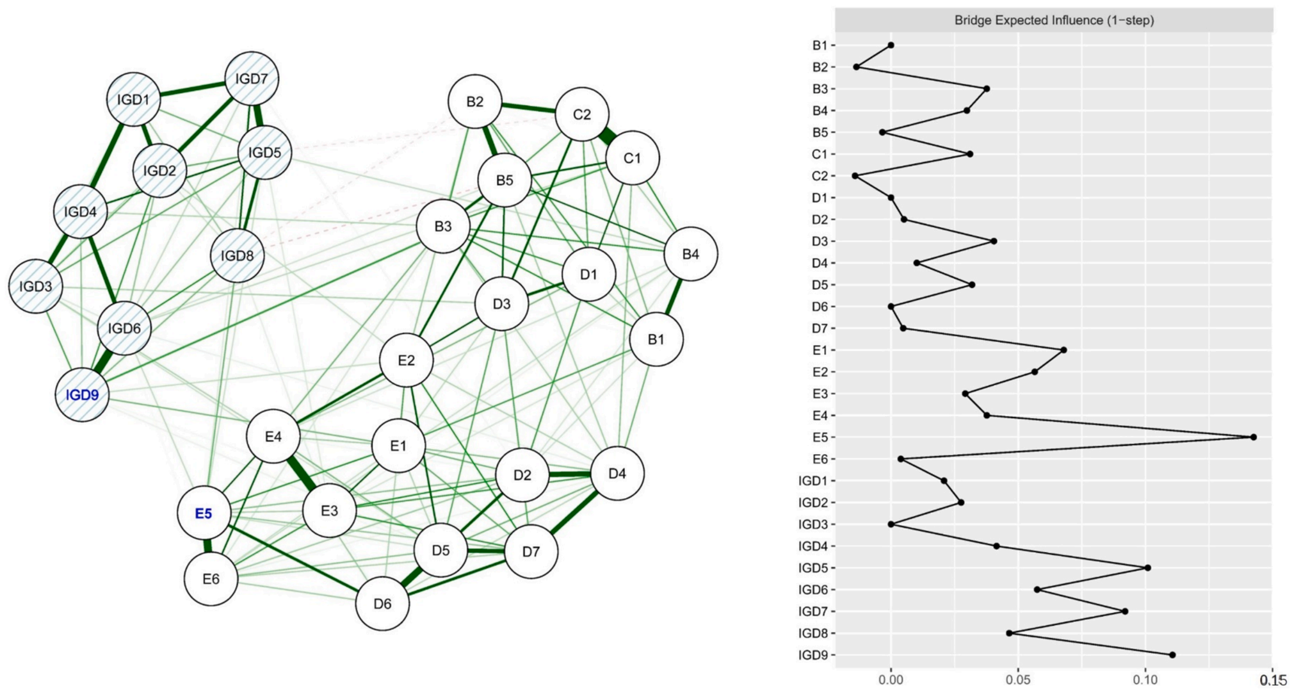


**Fig. 3.** Combined regularized partial correlation network model for posttraumatic stress symptoms (PTSS) and internet gaming disorder (IGD) symptoms and bridge expected influence (BEI) values for each node. Note: Bridge nodes with large BEI values are represented by blue text (E5 and IGD9). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

casual associations between symptoms and disorders in addition to hypothesis generation, data from the current study were based on a non-experimental, cross-sectional design, which precludes drawing causal inferences about relations between symptoms of PTSD and IGD (Fried & Cramer, 2017; Lazarov et al., 2020). Therefore, although our results provide initial empirical foundations for future hypothesis tests, future longitudinal research and experimental paradigms such as those based on randomized control trials, are needed to clarify temporal sequences and potential causal linkage between PTSD symptoms and IGD symptoms (Yuan, Park et al., 2021). Second, data were collected via self-report questionnaires, which might lead to response biases (Richardson et al., 2009). Future research should gather data via multiple methods (e.g., structured diagnostic interviews, observer ratings, mixed-methods). Third, the sample size was limited by an unequal gender distribution. Fourth, aside from the packages used in the present study, *mgm* package is an alternative way to model networks with mixed types of data via the mixed graphical models approach (Haslbeck & Waldorp, 2015, 2018, 2020), according to Burger et al. (2020)'s suggestions. Additionally, bridge centrality may have no indication of effect size, leaving conclusions about which bridge symptoms are meaningful to be subjective (Christensen et al., 2021). Beyond this, the present study applied an IGD questionnaire relating to the DSM-5 framework to study Internet Gaming Disorder. Recent works by Pontes et al. (2021) and Montag et al. (2019) put forward the Gaming Disorder Test, which has been constructed against the WHO framework, where Gaming Disorder is officially recognized. The mentioned papers showed that prevalence for (Internet) Gaming Disorder differ, when both frameworks are compared and this will be of further interest in the near future (although it also true that both frameworks overlap to a large extent, including neurobiological findings, Zhou et al., 2020). Please note that in the present work the WHO guidelines could not be applied, because in 2018 no official Gaming Disorder existed, and the DSM-5 framework was the most up to date.

In spite of the limitations, our findings have several important implications for future clinical practice. The current study highlights difficulty concentrating and conflict due to gaming as two critical bridge symptoms between PTSS and IGD symptoms among disaster-exposed individuals. Mindfulness-based therapy, a popular form of cognitive treatment in contemporary psychotherapy (Hofmann et al., 2010; Salmon et al., 2009), can significantly increase patients' concentration levels (Kropp & Sedlmeier, 2019) and effectively cope with trouble concentrating (Kim et al., 2013), which helps to reduce emotional distress (e.g., PTSS, depression, and anxiety) (Boyd et al., 2018; Cladder-Micus et al., 2018; Hall et al., 2018; Hofmann & Gómez, 2017). Psychotherapies incorporating mindfulness techniques also show clinical efficacy in the treatment of addictive disorders (Rosenthal et al., 2021) and can be delivered to trauma-exposed individuals using convenient digital intervention technology (Possemato et al., 2016). Mindfulness-oriented treatments and cognitive-behavioral therapies have been found effective in reducing and treating IGD symptoms (Li et al., 2017; Li et al., 2018; Stevens et al., 2019; Zajac et al., 2020). In addition, interventions that focus on psychosocial support and attempt to alleviate conflict due to gaming should be considered when clinicians are trying to treat the potential comorbidity of PTSD and IGD among trauma-exposed young adults. For example, Welton-Mitchell (2013) provided formal recommendations for responding to disaster-exposed individuals' mental health and psychosocial needs after trauma, especially attempting to increase availability and utilization of formal mental health and psychosocial support. Mindfulness-based interventions in tandem with Welton-Mitchell's suggestions provide a possible direction for future clinical research to address the comorbidity of PTSD and other addictive disorders in the aftermath of environmental disasters.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.

org/10.1016/j.addbeh.2021.107096.

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