Observational Study

Medicine

OPEN

Central symptoms of post-traumatic stress disorder on adult victims of sexual violence

A network analysis

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Abstract

This study aimed to identify and compare central post-traumatic stress disorder (PTSD) symptoms experienced by rape and sexual harassment victims, and the differences between the 2 groups. This study included 935 female victims of sexual violence who visited Sunflower Center in Korea between 2014 and 2020. Of the 935 victims, 172 were rape victims and 763 were sexually harassed. The Korean version of the Post-traumatic Diagnosis Scale was used to evaluate PTSD symptoms, and network analysis was performed to examine the differences in symptoms. The central symptom was "Physical reactions (PDS05)" for the group of rape victims and Less interest in activities (PDS09)' for the group of sexual harassment victims. For the group of sexual harassment victims, the most distinct central edge was the one between "Being over alert (PDS16)" and "Being jumpy or easily startled (PDS17)," and for the group of rape victims, it was the edge between "Upset when reminded of the trauma (PDS04)," and "Physical reactions (PDS05)." Network analysis revealed differences in central PTSD symptoms and central edges between sexual harassment and rape victims. Although re-experiencing and avoidance symptom clusters were most central in both groups, the specific central symptoms and edges differed between the 2 groups.

Abbreviations: CS = correlation stability, PDS = Post-traumatic Diagnosis Scale, PTSD = post-traumatic stress disorder.

Keywords: central symptom, network analysis, post-traumatic stress disorder (PTSD), sexual violence

1. Introduction

Sexual violence is perceived as a shock and traumatic event by individuals, and victims of sexual violence have a high incidence of post-traumatic stress disorder (PTSD).[1–3] PTSD is characterized by intrusive thoughts, avoidance of stimuli, negative alterations in cognition and mood, and marked alterations in arousal and reactivity. The lifetime prevalence of PTSD in the general population is reported to be 1 to 14%.[4] Ullman et al[5] reported that even several months after sexual violence, approximately 50% of female victims of sexual violence experienced PTSD symptoms such as flashbacks, nightmares, and exaggerated startle responses. It seems that the majority of victims of sexual violence are diagnosed with short- or long-term PTSD or experience-related symptoms.

Although the symptom clusters of PTSD (re-experiencing, avoidance, hyperarousal) seem to be related to its progression, inconsistent results have been reported. Schell et al[6] reported that hyperarousal predicted the severity of all other symptoms in assessments performed 3 and 12 months after the occurrence of sexual violence. Stein et al[7] suggested that attention should be paid to hyperarousal in treating victims of sexual violence and that hyperarousal may distract victims and prevent them from participating in treatment. However, Creamer et al[8] suggested that the re-experiencing symptom cluster is most clinically relevant to the severity of PTSD, and Shalev[9] suggested that high levels of re-experience and hyperarousal reinforce the learning that occurs during a traumatic event, contributing to the development and maintenance of PTSD. Additionally, avoidance symptoms have been reported to predict PTSD.[10] Clark[11] argued that avoidance is used in an attempt to reduce stress related to hyperarousal and re-experiencing; however, in the long term, it contributes to the maintenance of PTSD. Similarly, studies on PTSD symptom clusters and the severity and progression of PTSD have produced inconsistent results. Using these

The authors have no funding to disclose.

The authors have no conflicts of interest to disclose.

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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How to cite this article: Yang SB, Choi SS, Chang HY, Kim D, Lee Y, Lim MH. Central symptoms of post-traumatic stress disorder on adult victims of sexual violence: A network analysis. Medicine 2023;102:27(e34083).

Received: 6 April 2023 / Received in final form: 30 May 2023 / Accepted: 2 June 2023

http://dx.doi.org/10.1097/MD.0000000000034083

results to infer PTSD symptom patterns in Korean female victims of sexual violence and rape in adulthood has some limitations; thus, further research is required.

In previous studies on PTSD symptoms among victims of sexual violence conducted in Korea, the participants were mostly victims of rape and sexual harassment. Psychological damage caused by sexual harassment is considered minor compared to that caused by rape, but victims of sexual harassment also complain of severe psychological symptoms, such as depression, anxiety, stress, and PTSD.[12–15] Therefore, a systematic treatment approach based on an intensive analysis of victims of sexual harassment is necessary, as is the treatment of victims of rape. In reality, there are insufficient studies on the analyses performed according to the type of sexual violence.

Therefore, this study compared and analyzed the complaints of PTSD symptoms according to the type of sexual violence using a network model. The network model is a new approach to understanding mental disorders, as it describes the central symptoms of a disorder and their connectivity.[16–18] In conventional approaches, the symptoms of mental disorders are understood to occur because of common latent variables.[19,20] In other words, it is assumed that all symptoms are conditionally independent of one another owing to latent variables. However, such latent variables are rarely observed directly, and this assumption contradicts a report by other studies that PTSD symptoms are caused by other PTSD symptoms.[19,20] Consequently, the use of latent variables to explain the relationships between symptoms may have limitations. In contrast, the network model describes the relationships between symptoms without assuming latent variables.[19,20] Therefore, it reveals interactions between symptoms in a more specific manner than conventional models. Consequently, this study utilized network analysis to investigate PTSD symptoms experienced by rape and sexual harassment victims, identify central symptoms and connectivity, and compare the results.

The objective of this study was to identify the central symptoms and the most distinct connectivity and to identify the key symptom clusters that are essential for the spread of symptoms. Appropriate centrality criteria were used to verify the results followed by statistical testing. Finally, key clusters of PTSD symptoms were identified based on the results.

2. Methods

2.1. Study design

In this study, victims of rape and sexual harassment self-reported PTSD severity according to the Korean version of the Post-traumatic Diagnosis Scale (PDS-K) scale and were subsequently divided into subgroups. Networks were estimated and centrality indices were calculated using statistical methods within each subgroup. Central symptoms were specified after testing for stability and significant differences, and central connectivity was identified using statistical difference tests. Based on these results, the most important cluster of PTSD symptoms was identified and discussed in relation to the growth of other symptoms.

2.2. Definition and classification of sexual violence

For the purpose of this study, sexual violence is defined as "any sexual act that is forced upon another person without the person's voluntary consent." There are 2 categories of sexual violence: rape and sexual harassment. Rape is defined as any "unwanted penetration" that is forced upon another person against the person's will; and sexual harassment as an unwanted "act of physical contact," excluding penetration, that makes the victim feel sexually humiliated or disgusted.

2.3. Participants and procedure

Data were obtained from the Sunflower Center of Southern Gyeonggi-do, for victims of violence, at the Ajou University Hospital in Korea. Upon registration, the victims signed consent forms for the assessment. The participants were 935 female victims of sexual violence who agreed to participate in the study and visited the Sunflower Center in Southern Gyeonggi-do, Republic of Korea, between January 2014 and December 2020. Of the 935 victims, 172 were victims of rape with an average age of 33.31 years (standard deviation: 9.62). The average age of the 763 sexual harassment victims was 32.25 years (SD: 9.44).

2.4. Ethical approval and informed consent

This study was performed in accordance with the Declaration of Helsinki and approved by the Institutional Review Board of Dankook University (DKU 2022-10-060-001). We provided the subjects participating in this study with sufficient explanations regarding the purpose of this study and obtained their written consent, following the research procedure before the study began. Their participation was voluntary and they were informed that they could withdraw their consent at any time during the study.

2.5. Measure

This study used the PDS-K,[21] which was developed by Nam Bora by adapting the Post-traumatic Diagnosis Scale (PDS),[22] a self-report instrument for PTSD developed by Foa et al, to evaluate PTSD symptoms. The PDS-K has 17 items that measure PTSD symptoms in 3 categories: re-experiencing (5 items), avoidance (7 items), and hyperarousal (5 items). The items are rated on a 4-point scale (0 = never, 3 = at least 5 times a week). Regarding the internal consistency of the items, the PDS-K obtained Cronbach α = 0.95 in this study,[21] which is close to the PDS (Cronbach α = 0.92).[22] The test-retest reliability coefficient was 0.81, indicating a high level of reliability.[22] The datasets analyzed during the current study are not publicly available owing to ethical issues but are available from the corresponding author upon reasonable request.

2.6. Data analytic plan

2.6.1. Estimating network. Network analysis was performed to compare the aspects of PTSD symptoms experienced by victims of sexual violence using R studio Version 4.2.2. (Posit Inc., Boston, MA). The network uses a Gaussian Graphical Model,[23,24] which is a type of Pairwise Markov Random Field.[23,25] Each node represents a symptom, and the weight of each edge linking the 2 nodes is a partial correlation coefficient.[26] An appropriate network was estimated using the least absolute shrinkage and selection operator[27] and the Extended Bayesian Information Criterion.[28] In the estimated network, the node centrality can be identified using different indices.

Among these, strength, closeness, betweenness, and expected influence are the most representative indices. Strength is the sum of all absolute values of the weights of the edges connected to a node and indicates how strongly the node is directly connected to other nodes. Closeness indicates the proximity of a node to all other nodes in the network. Betweenness indicates the importance of a node in terms of its indirect relationships with the other nodes within a network. Expected influence is the sum of edge weights, whereas strength is the sum of absolute values of edge weights. Expected influence and strength centrality were similar. However, the expected influence is suitable when there are edges with a negative partial correlation coefficient.

2.6.2. Network accuracy. To verify the accuracy of the network, the 3 steps suggested by Epskamp et al[26] were carried out. First, the bootstrap[29] method was used to estimate the confidence intervals of the edge weights. The correlation stability (CS) coefficient was then calculated to estimate the stability of the node centrality indices. A CS coefficient of 0.5 or greater is recommended, and the centrality indices of each node can be seen as having different values only when the CS coefficient is at least 0.25.[26] Lastly, 2 aspects were investigated: whether values of edge weights are different from one another, and whether values of centrality indices of a node are different from one another on a statistically significant level.

2.6.3. Network comparison. A network comparison test[30] was performed to compare the respective networks of the 2 groups. First, we investigated whether the null hypothesis, which argues that all the edge weight values of the 2 groups are the same, can be rejected. If the null hypothesis was rejected, specific edges with different weight values are investigated. Finally, we investigated whether the global strength, which is the sum of the strengths of all the nodes in each network, differs between the 2 networks on a statistically significant level. A higher global strength indicates a network with higher density, and it was determined whether the 2 networks had statistically significant differences in density. The R package Network Comparison Test was used for the analysis.

3. Results

3.1. Descriptive statistics

A total of 935 female victims of sexual violence participated in this study, with 172 reporting a history of rape, and 763 reporting a history of sexual harassment. The average age of the participants was 32.51 years. The average age of the rape victim group was 33.31 years, whereas that of the sexual harassment victim group was 32.25 years. The severity of PTSD was measured using the PDS-K, which utilizes 17 variables represented by symbols, namely PDS01-PDS17 (Table 1).

The incidences of symptoms were 45.13% and 45.79% in the rape victim and sexual harassment groups, respectively. The average severity level of the overall symptoms was higher in the group of victims of sexual harassment (average: 1.59) than in the group of victims of rape (average: 1.50). The Wilcoxon rank sum test revealed that the difference was statistically significant ($P < .001$). The test was performed to compare the scores of individual symptoms ($\alpha = .05$). "Not able to remember" ($P < .001$) and "Feeling emotionally numb" ($P = .002$) showed the largest differences in the severity level of a symptom, and the severity levels of both symptoms were higher in the group of victims of sexual harassment. Statistically significant differences in the severity of symptoms between the 2 groups were also found for the following symptoms: "Less interest in activities (PDS09)," "Feeling plans won't come true (PDS12)," "Having trouble sleeping (PDS13)," and "Being over alert (PDS16)." "Being over alert (PDS16)" is the only symptom for which the group of victims of rape had a higher severity level.

Table 1

PTSD symptoms.

Symptom abbreviation	Symptom cluster	Symptom description
PDS01	Re-experiencing symptoms	Upsetting thoughts or images
PDS02		Bad dreams about the trauma
PDS03		"Reliving the trauma"
PDS04		Upset when reminded of trauma
PDS05		Physical reactions
PDS06	Avoidance symptoms	Not thinking about trauma
PDS07		Avoid reminds of the trauma
PDS08		Not able to remember
PDS09		Less interest in activities
PDS10		Distant or cut off from people
PDS11		Feeling emotionally numb
PDS12		Feeling plans won't come true
PDS13	Hyperarousal symptoms	Having trouble sleeping
PDS14		Feeling irritable
PDS15		Having trouble concentrating
PDS16		Being over alert
PDS17		Being jumpy or easily startled

PTSD = post-traumatic stress disorder.

3.2. Partial correlation network

3.2.1. Estimating network. The networks of PTSD symptoms were estimated through least absolute shrinkage and selection operator regularization using a polychoric correlation coefficient, which is a type of partial correlation coefficient, and the Gaussian Graphical Model (Fig. 1). R packages such as qgraph and bootnet were used. The estimated network of rape victims consisted of 17 nodes and 82 edges out of 136 possible edges, and the estimated network of sexual harassment victims consisted of 17 nodes and 100 edges out of 136 possible edges. The values of the 4 centrality indices are marked on graphs to identify the central symptoms in the 2 estimated networks (Fig. 2). The R package qgraph was used for statistical analysis.

3.2.2. Network accuracy. The network of the group of rape victims has 13 edges that can be said to have weights high enough with no "0" in the bootstrap confidence interval; the network of the group of victims of sexual harassment has 40 such edges. For the network of the group of victims of rape, the most distinct edges were those between: "Upset when reminded of the trauma (PDS04)" and "Physical reactions (PDS05)"; and "Not thinking about the trauma (PDS06)" and "Avoidance of reminders of the trauma (PDS07)." For the network of the group of victims of sexual harassment, the most distinctive edges were those between: "Being over alert (PDS16)" and "Being jumpy or easily startled (PDS17)"; "Not thinking about trauma (PDS06)" and "Avoidance of reminders of the trauma (PDS07)"; "Feeling irritable (PDS14)" and "Having trouble concentrating (PDS15)"; and "Distant or cut off from people (PDS10)" and "Feeling plans won't come true (PDS12)."

The CS coefficients obtained to verify the stability of centrality indices were 0.28 for strength, 0.28 for expected influence, 0.20 for closeness, and 0.00 for betweenness in the network of the group of victims of rape: In the network of the group of victims of sexual harassment, such CS coefficients were 0.75 for strength, 0.75 for expected influence, 0.44 for closeness, and 0.21 for betweenness. Consequently, the central nodes can be identified using the CS coefficients for strength and expected influence. As only 2 edges had negative correlation coefficients, the central nodes were selected using strength, which is more intuitive than the expected influence.

Strength values were z-scaled for each group to identify nodes with high strength values. Symptoms with a z-value of 1 or greater, which played a relatively central role, were identified. For the group of victims of rape, symptoms with a z-value of 1 or greater were "Physical reactions (PDS05)" ($z = 1.66$), "Having trouble sleeping (PDS13)" ($z = 1.31$), "Having trouble concentrating (PDS15)" ($z = 1.24$), "Less interest in activities (PDS09)" (1.17), and "Distant or cut off from people (PDS10)" ($z = 1.15$). For the group of victims of sexual harassment, such symptoms were "Less interest in activities (PDS09)" ($z = 1.55$), "Upsetting thoughts or images (PDS01)" ($z = 1.19$), "Having trouble concentrating (PDS15)" ($z = 1.16$), and "Physical reactions (PDS05)" ($z = 1.09$).

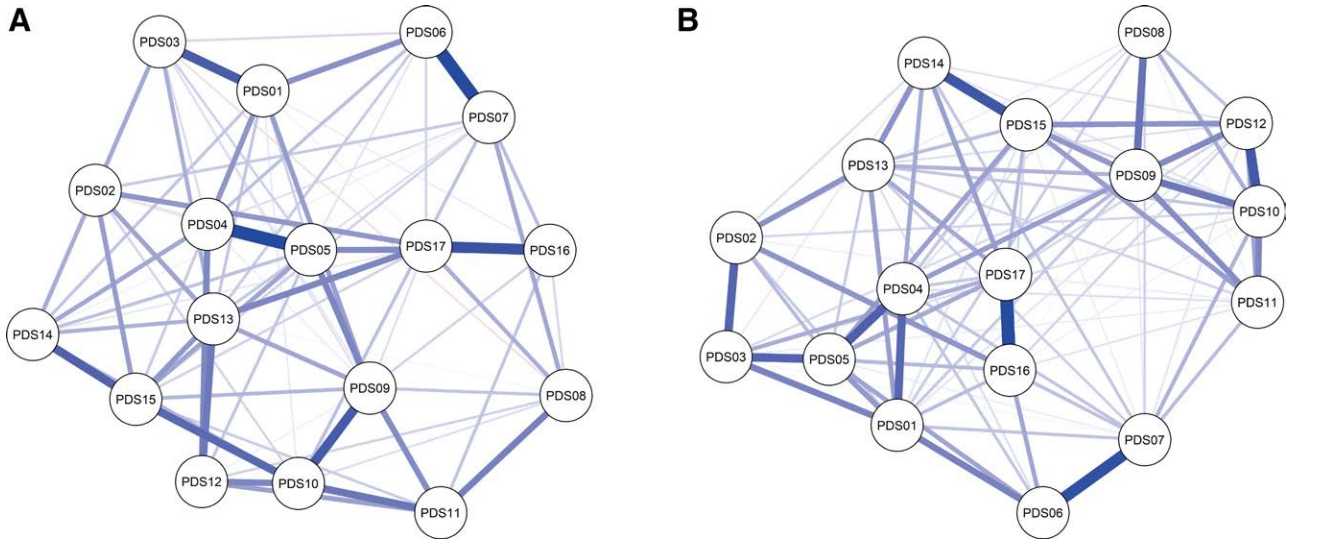

Figure 1. Network structures of PTSD symptoms. (A) Group of rape victims. (B) Group of sexual harassment victims. PTSD = post-traumatic stress disorder.

Next, we investigated at a significance level of 0.05 whether the strength values of those nodes were larger than the strength values of other nodes at a statistically significant level (Fig. 3). The investigation found that symptoms with a *z*-value of 1 or greater had strength values higher than approximately half of all the nodes in both networks at a statistically significant level.

The same significance level was investigated to determine whether the weight values of the most distinct edges were significantly larger than those of the other edges in the 2 networks (Fig. 4). The investigation found that the 2 most distinct edges in the network of rape victims and the 4 most distinct edges in the network of sexual harassment victims had higher weight values than almost all other edges on a statistically significant level.

3.2.3. Network comparison. Finally, we investigated whether there were statistically significant differences in node and edge values between the 2 subpopulations. First, we investigate whether the same edges have the same weight. The results indicated that the edge values did not differ significantly. (P = .73) This should not be interpreted as an indication that the 2 networks have the same structure. A reasonable interpretation is that there is no marked difference between the structures of the 2 networks.[30]

3.3. Central symptom analysis

Based on the above results, the characteristics of the 2 networks were examined to identify central symptoms. For the group of rape victims, the central symptoms were "Physical reactions (PDS05)," "Having trouble sleeping (PDS13)," "Having trouble concentrating (PDS15)," "Less interest in activities (PDS09)" and "Distant or cut off from people (PDS10)," with PDS05 being the most distinct central symptom. For the group of victims of sexual harassment, the central symptoms were "Less interest in activities (PDS09)," "Upsetting thoughts or images (PDS01)," "Having trouble concentrating (PDS15)," and "Physical reactions (PDS05)" with PDS09 being the most distinct.

For the group of victims of rape, the identified central edges were the edges between "Upset when reminded of the trauma (PDS04)" and "Physical reactions (PDS05)"; and "Not thinking about the trauma (PDS06)" and "Avoidance of reminders of the trauma (PDS07)." For the group of victims of sexual harassment, the central edges were those between "Being over alert (PDS16)" and "Being jumpy or easily startled (PDS17)"; "Not thinking about the trauma (PDS06)" and "Avoidance of reminders of the trauma (PDS07)"; "Feeling irritable (PDS14)" and "Having trouble concentrating (PDS15)"; and "Distant or cut off from people (PDS10)" and "Feeling plans won't come true (PDS12)." Particularly, the most distinct central edge was the one between PDS04 and PDS05 for the group of victims of rape and the one between PDS167 and PDS17 for the group of victims of sexual harassment.

4. Discussion

This study used network analysis to identify central PTSD symptoms in a group of rape victims and a group of sexual harassment victims and examined differences in central edges and nodes between the 2 networks of the groups. This study also aimed to analyze the aspects of PTSD symptoms experienced by female victims of sexual violence in Korea and identify the most central symptom clusters, because previous studies on PTSD have produced inconsistent results.

Before discussing the results of the network analysis, the average severity level and incidence of overall symptoms were compared between the 2 groups. The average severity of symptoms was significantly higher in the sexual harassment victims than in the rape victims (P < .001). The comparison of the severity levels of individual symptoms found that the severity levels of "Not able to remember (PDS08)" and "Feeling emotionally numb (PDS11)" were higher in the group of victims of sexual harassment than in the group victims of rape on a statistically significant level. "Being over alert (PDS16)" was the only symptom that was reported to be more severe in the group of victims of rape than in the group of victims of sexual harassment. These results are in agreement with those of studies that reported that the characteristics of sexual violence, such as threats to life, use of verbal and physical force, and rape, are related to the severity of PTSD.[31,32] However, it has been reported that the severity of PTSD is affected more by other factors, such as psychosocial variables after sexual violence or victims' perceptions related to traumatic events than by the characteristics of sexual violence.[5,33] It has been found that these symptoms all had the lowest values of centrality indices and had minor effects on the networks, meaning that they were present, independent of other symptoms. Therefore, simply comparing the severity level of symptoms has limitations when comparing and analyzing aspects of PTSD symptoms between the 2 groups. The incidence of symptoms was similar at 40 to 50% in both groups. This corresponds with the results of a previous study that compared the psychological symptoms of victims of sexual harassment and victims of rape and found no statistically significant

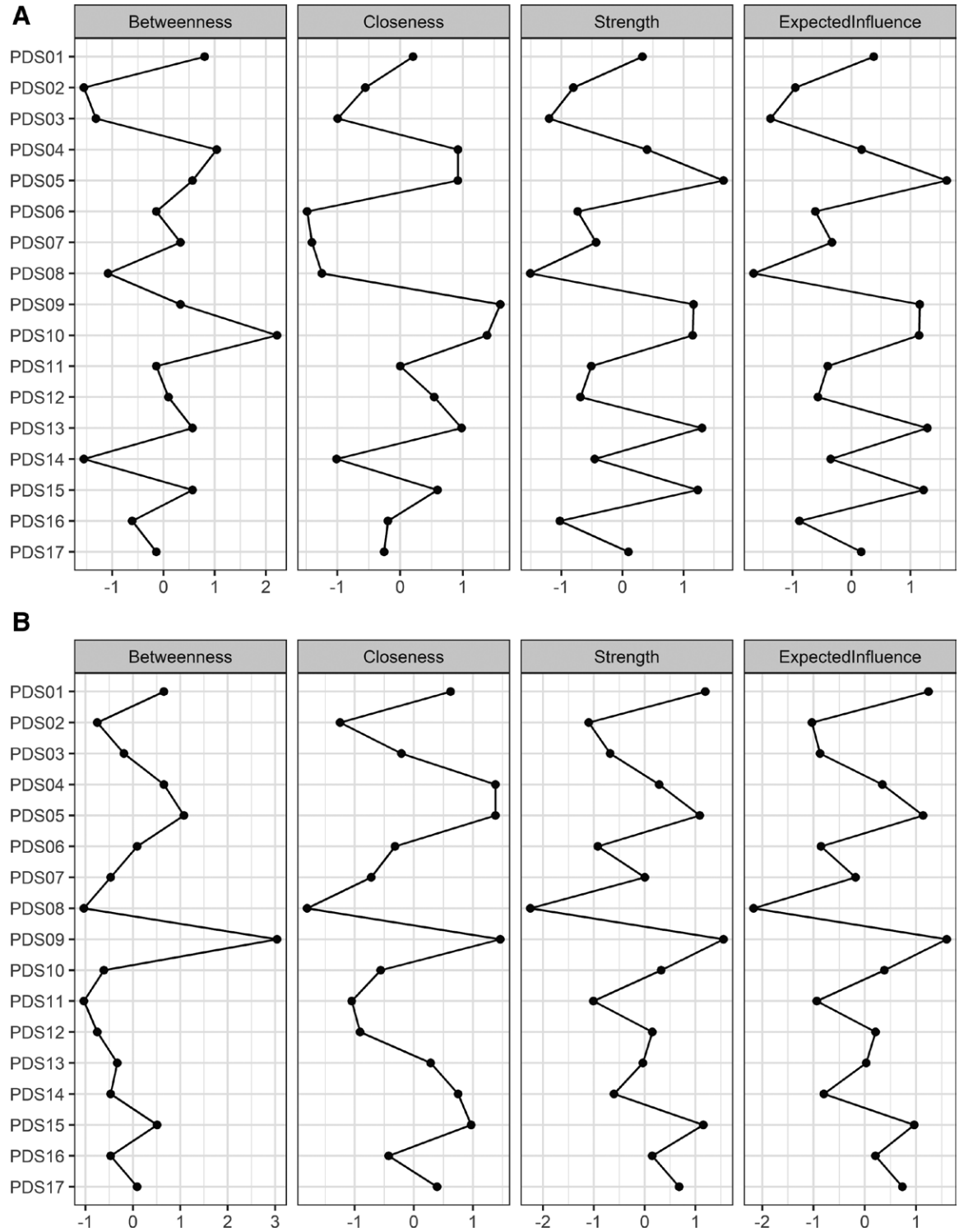

Figure 2. Centrality indices plot. (A) Group of rape victims. (B) Group of sexual harassment victims.

difference.[3] In this study, the rates of victims of sexual harassment and victims of rape who had statistically significant scores on a PTSD screening test performed within 3 months after the occurrence of sexual violence were 94.4% and 95.5%, respectively. Therefore, victims of sexual harassment experience PTSD symptoms as severe as those experienced by victims of rape in the initial period after the sexual violence occurs.

The results of the network analysis show that the most distinct central symptom in the group of victims of rape is "physical reactions (PDS05)," which belong to the re-experiencing symptom cluster and that this symptom plays a central role in the group of victims of sexual harassment. The finding that the re-experiencing symptom cluster plays an important role is similar to the results of previous studies[34] that compared the PTSD symptoms of victims of sexual harassment with those of victims of rape. However, the relevance of this symptom to other symptoms in the network differed between the 2 groups. In the group of victims of rape, the symptoms forming the most distinct edge between "Upset when reminded of the trauma (PDS04)" and "Physical reactions (PDS05)," did not show clear connectivity

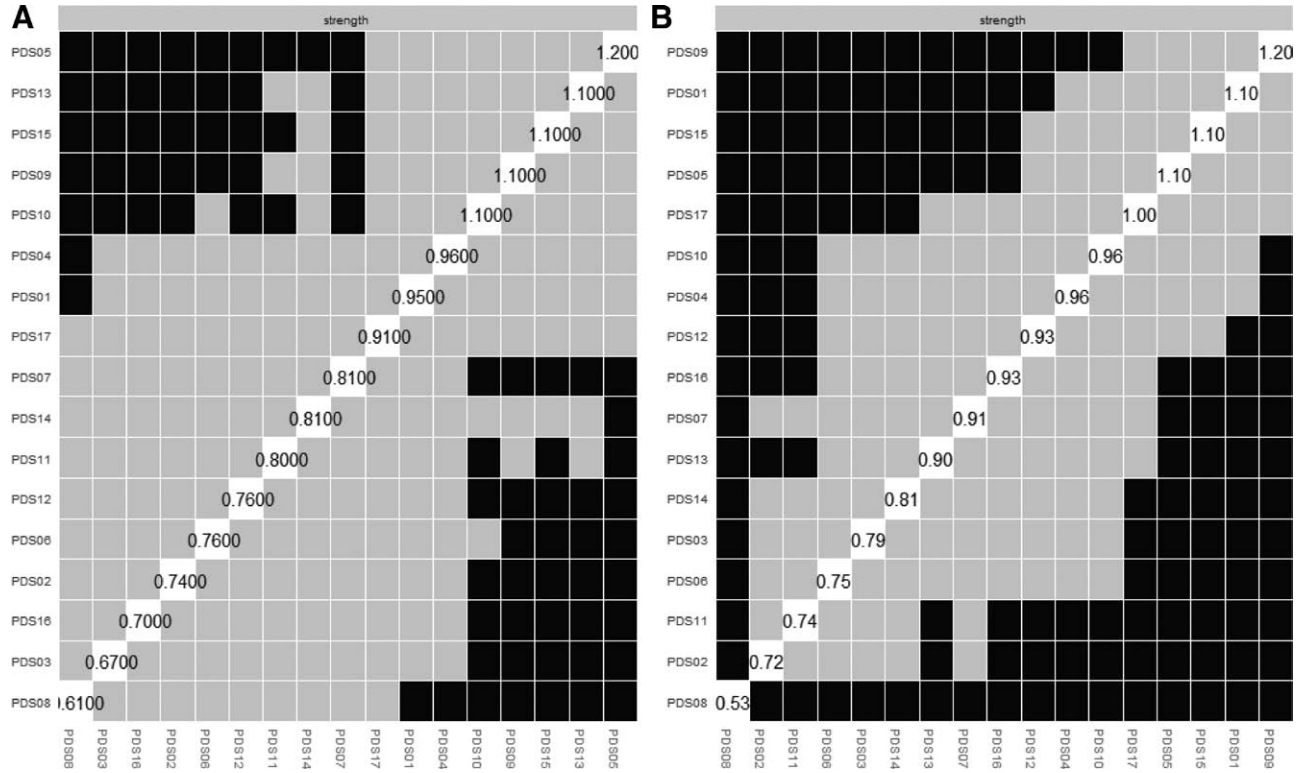

Figure 3. Node centrality difference test. (A) Group of rape victims. (B) Group of sexual harassment victims.

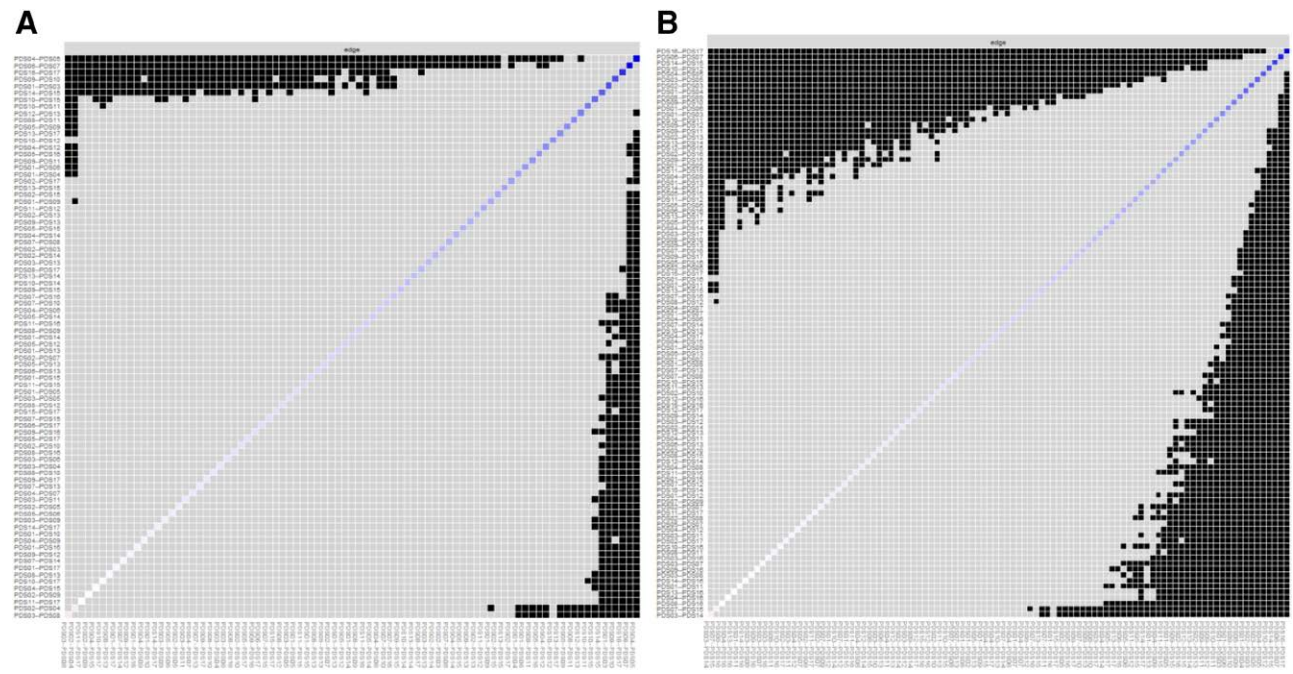

Figure 4. Edge weight difference test. (A) Group of rape victims. (B) Group of sexual harassment victims.

with other symptoms. Therefore, these 2 symptoms are highly relevant to specific symptoms. In contrast, in the group of victims of sexual harassment, "Physical reactions (PDS05)" were the central symptom, and the node representing this was linked through multiple edges to other nodes. It had particularly high relevance with "Reliving the trauma (PDS03)" and "Upset when reminded of the trauma (PDS04)."

In the group of victims of sexual harassment, "Less interest in activities (PDS09)," which belonged to the avoidance symptom cluster, was found to be the most distinct central symptom. As the node representing the symptom was not linked to other nodes through central edges with high weights in the group of sexual harassment victims, it seemed that the symptoms occurred with overall symptoms, rather than with specific

symptoms. Simultaneously, it plays a central role in the group of rape victims. "Distant or cut off from people (PDS10)" were connected to PDS09 through a central edge, while no clear connectivity with other symptoms appeared. Therefore, it was found that less interest in activities (PDS09) was highly relevant to a specific symptom, unlike in the network of victims of sexual harassment. Preventing memories of a traumatic event from being reinstated and avoiding stimuli that can evoke memories of the event are among the common responses observed in victims of sexual violence.[35,36] It was found that a high level of avoidance symptoms negatively affected the overall progression of PTSD and reduced the possibility of victims reporting sexual violence.[37,38] According to Walsh[39] and Clark,[11] avoidance is an attempt to reduce stress related to hyperarousal and re-experiencing but contributes to the maintenance of PTSD in the long run. The most distinct central edge in the group of victims of sexual harassment was the one between "Being over alert (PDS16)" and "Being jumpy or easily startled (PDS17)." These 2 symptoms did not exhibit high centrality index values. Despite the high relevance between the 2 symptoms, they had minor effects on the entire network.

The limitations of this study and suggestions for further research are as follows. First, despite the assumption of the network model that the onset of central symptoms contributes to the onset and chronicization of the disorder, this study estimated networks based on cross-sectional data; thus, the relevance between symptoms is nondirectional, and there are limitations in interpreting cause-and-effect relationships.[40] Therefore, further research needs to use longitudinal data to clearly identify the mechanism of PTSD pathogenesis, based on the relevance between the symptoms identified in this study. In addition, the networks of PTSD symptoms were estimated based on the average values obtained from the 2 groups and might not exactly reflect the interactions between the symptoms of specific individuals. Therefore, further research is needed to determine whether the networks of a group and an individual have the same structure.

Second, only 172 rape victims participated in this study, and they did not form a sufficiently large sample. A sample with a small number of participants may undermine network stability. However, in this study, the CS coefficient was larger than the minimum required level of 0.25, which enabled a meaningful network interpretation despite the small number of participants in the dataset. In future research, it will be meaningful to obtain a sufficient number of participants and compare the symptoms of rape victims, sexual harassment victims, and the entire group. This study examined 2 major types of sexual violence: rape and sexual harassment. Further research will be required to deal with various types of sexual violence that have been increasing recently, such as illegal filming and obscene crimes, and the corresponding groups of victims of sexual violence need to be identified and their symptoms analyzed to provide intervention and treatment accordingly.

Despite the aforementioned limitations, this study has significance in that it is the first study in Korea to analyze the structures of networks of PTSD symptoms according to the type of sexual violence and has provided data that can aid in understanding victims of rape and sexual harassment.

Author contributions

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Visualization: Dohyun Kim, Myung Ho Lim.
Writing – original draft: Saet Byeol Yang.
Writing – review & editing: Myung Ho Lim.

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