Analysis of the semantic network of post-traumatic stress disorder using Korean social big data

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ABSTRACT

Introduction: In this study, we wanted to examine how post-traumatic stress disorder was discussed in Korean newspaper articles with semantic network analysis suitable for unstructured big data analysis.

Methods: This study analyzed 11,304 articles related to post-traumatic stress reported by four major Korean newspapers for three years from July 30, 2017, to July 30, 2020. R 3.6.2 program was used to calculate TF and TF-IDF values, and UCINET 6.0 and interlocked NetDraw were used for DC, EC, and CONCOR values.

Results: As a result of deriving 50 major keywords with high TF-IDF values in newspaper articles related to a post-traumatic stress disorder, TF-IDF values were high in the order of ‘sick leave’, ‘solitary confinement’, ‘detention center’, ‘standing order’, and ‘prisoner’. As a result of conducting a CONCOR analysis to determine which sub-clusters keywords are classified into, the researcher derived each cluster based on words included: ‘PTSD by crops’ (cluster 1), ‘PTSD by broadcasting accidents’ (clusters), ‘PTSD by farm livestock accidents’ (cluster 3), and ‘PTSD by various accidents’ (cluster 4).

Conclusion: Based on the research results, post-traumatic stress disorder needs to be managed nationally. As such, we intend to provide basic data for policy development and intervention programs.

Key words: Big data, Data mining, Semantics, Stress Disorders

INTRODUCTION

In modern society, the risk of developing various problems related to stress and mental health is gradually increasing as various events, natural and human disasters, accidents, diseases, and internal conflicts, occur frequently. Among them, Post Traumatic Stress Disorder (PTSD) is a psychiatric disorder in which various physical and mental symptoms are experienced by exposure to traumatic events. PTSD has characteristic symptoms of decreasing quality of life such as re-experiencing repeatedly and recalling traumatic events, avoidance of event-related factors, persistent hyperactivity, interpersonal relationship atrophy, sleep disorders, and memory impairment. Several previous studies have discussed that PTSD patients have a high incidence of various mental disorders such as substance use disorder, panic disorder, depressive disorder, anxiety disorder, and personality disorder with a higher level of depression and anxiety compared to the normal population. Up to date, studies compared the incidence rate between occupations and analyzed the influencing factors through statistical survey data related to PTSD, but these only focused on individual factors set by the researcher, a limited viewpoint on PTSD.

To compensate for these limitations, various academic fields are actively attempting to derive meaning by
an analyzing big data produced through the spread of mobile devices and active social media. Big data analysis is a technology that extracts value and analyzes the results using tens to thousands of terabytes of structured and unstructured data, exceeding the capabilities of existing database management tools. Big data is generated and spread in various forms such as text documents, images, and videos. Among them, newspaper articles are records reflecting issues and events through representative media, reflecting past to present trends, and predicting the future. The importance of newspaper data is emerging with the potential of providing valuable information in various areas such as politics, society, economy, science, and culture. In this regard, applying a big data analysis on PTSD newspaper articles could derive data that could understand and track PTSD in-depth, and find the hidden context and meaning in a large amount of information using keywords and network analysis.

This study was aimed to examine the pattern of post-traumatic stress disorder in Korean newspaper articles with semantic network analysis suitable for unstructured big data analysis and to examine the meaning of keywords and the relationship structure between words. Through this approach, we intended to provide basic data preparing the post-traumatic stress national management plan.

The specific research questions for the above purpose are as follows.
- What are the keywords appearing frequently in post-traumatic stress disorder newspaper articles?
- Which of the keywords related to post-traumatic stress disorder are highly centralized?
- In what subgroups are words classified within the network of keywords?

METHODS

The data was collected with keywords among post-traumatic stress-related social big data, “PTSD”, “trauma”, “disability”, “stress”, “post-traumatic”. As a result of searching for data with the mentioned keywords, 11,304 documents were derived. We crawled articles from July 30, 2017, to July 30, 2020, reported in major Korean newspapers “JoongAng Ilbo”, “Chosun Ilbo”, “Dong-A Ilbo”, and “Yonhap Shinmun”. Keyword words were searched in both Korean and English, and in the case of English, only terms that could be searched for data keywords were used using Mesh (https://www.ncbi.nlm.nih.gov/mesh/?term). In addition, for ambiguous terms in Korean and English, only terms that secured reliability through the agreement of two researchers were selected. Crawling refers to an automatic program retrieving and extracting specific information from a website. In the collected web documents, only the data including keywords in the original article was extracted, and similar words other than those collected in this study were not used. Accordingly, 11,304 cases reported in the newspaper were analyzed. In this study, unstructured web documents from crawling were processed into a structured state and integrated into words with similar meanings.

This study conducted TF (Term Frequency), TF-IDF (Term Frequency - Inverse Document Frequency), DC (Degree Centrality), EC (Eigenvector Centrality), CONCOR (CONvergence of Iteration CORelations) analysis for post-traumatic stress disorder using social big data. The R 3.6.2 program was used for the TF and TF-IDF values, and the UCINET 6.0 and interlocked NetDraw were used for the DC, EC, and CONCOR values.

The TF represents the number of specific words appeared, and the larger the TF value, the more important words in this study. TF-IDF evaluates the importance of the extracted word. The higher the TF-IDF value, the more likely the word contains the subject or meaning of this study, and could be importantly used to extract and analyze words that are frequently mentioned in documents. Based on the TF-IDF value, the final 50 keywords were selected and used for analysis. DC is a connection-centricity and is an index of how much a specific node relates to other nodes. A node with high DC has much correlation with other nodes in the network, thus could be considered important in identifying correlation in the study. EC is an extended concept of DC, which evaluates the influence of other nodes connected to the node. We could estimate not only how relevant a particular node is to other nodes, but also how important the connected node is. CONCOR can identify keywords’ clusters by classifying the top 50 extracted words related to post-traumatic stress disorder into subgroups.

RESULTS

Keyword frequency analysis in PTSD related documents

The frequency analysis derived from the research results is as follows (Table 1). In PTSD-related
documents, high TF value words are “Sick leave”, 2nd place “Detention center”, 7th place “Solitary confinement”, and 8th place “Standing orders”. For TF-IDF value, the above words are also ranked 1st “Sick leave”, 2nd “Solitary confinement”, 3rd “Detention center”, and 4th “Standing orders”. These have been identified as the main keywords in the PTSD document as social phenomena such as military service and issues, always has been issues in Korean society, are linked to crime. From 11th to 50th, keywords in the PTSD document were derived from various incidents, originating from natural disasters (floods or heat waves) or human accidents such as “Live broadcast”, “Helicopter”, “Farm”, and “Breeding”.

Centrality and visualization of keywords
Analyzing words in post-traumatic stress disorder, the DC (Degree Centrality), and EC (Eigenvector Centrality) values of the words with the top 50 TF-IDF values are shown as follows (Table 2). Keywords with high DC values, 2nd place “Announcer”, 5th place “Influence of anger”, 8th place “Stock”, 9th place “Pig”, 10th place “Farm” had ranked relatively high compared to the TF-IDF value, assuming the relative importance implied is large. Keywords with high EC values, 2nd place “Announcer”, 5th place “Influence of anger”, 8th place “Stock”, 9th place “Pig”, 10th place “Farm” were similar to the DC value, assuming greater influence in the network than their relative frequency of appearance. The results of visualizing the keywords related to PTSD were as follows (Figure 1). The size of each node represents the connection center, and the larger the connection center is, the larger the node size.

Subgroup of keywords
In this study, we classified words into subgroups through PTSD-related CONCOR analysis, and the results were as follows (Fig. 2, Fig. 3, Table 3).
Cluster 1 named “PTSD for crops” includes words such as “Drive”, “Kimchi stuff”, and “Oriental melon”. Cluster 2 named “PTSD by broadcasting accidents” includes words such as “Live broadcast”, “Helicopter”, “Influence of anger”, and “Announcer”. Cluster 3 named “PTSD by farm livestock accidents” included words such as “Pig”, “Stock”, “Farm”, and “Breeding”. Cluster 4 named “PTSD by various accidents” included words such as “Prison officer”, “Offense”, “Prisoner”, “Parliamentary law”, “Standing orders”, “Performance”, and “Basic pay”. Korea recently has been exposed to various criminal accidents, and various struggles and discord between the state and labor have continuously occurred due to the rise of the minimum hourly wage. With the social trend, we could predict the reason behind the selection of the keywords. Accordingly, cluster 4 was named “PTSD caused by various accidents”.

![Figure 1: Full network visualization of keywords](attachment:image.png)
| TF | TF-IDF |
|----|--------|
| Sick leave | 0.019 | Sick leave | 0.021 |
| Detention center | 0.013 | Solitary confinement | 0.016 |
| Limb | 0.011 | Detention center | 0.014 |
| Announcer | 0.011 | Standing orders | 0.013 |
| Secretariat | 0.01 | Prisoner | 0.01 |
| Imprisonment | 0.009 | Annual expense | 0.009 |
| Solitary confinement | 0.009 | Secretariat | 0.007 |
| Standing orders | 0.007 | Workplace | 0.007 |
| Stock | 0.007 | Live broadcast | 0.006 |
| Helicopter | 0.006 | Application | 0.005 |
| Sister | 0.006 | Stock | 0.005 |
| Siblings | 0.006 | Leave of absence | 0.004 |
| Pig | 0.006 | Parliamentary law | 0.004 |
| Prisoner | 0.005 | Basic pay | 0.004 |
| Farm | 0.005 | Form | 0.004 |
| Influence of anger | 0.005 | Staggered break | 0.004 |
| Live broadcast | 0.005 | Helicopter | 0.004 |
| Application | 0.009 | Pig | 0.004 |
| Annual expense | 0.005 | Farm | 0.004 |
| Brother | 0.005 | Imprisonment | 0.004 |
| Farmhouse | 0.004 | Prison officer | 0.003 |
| Work place | 0.004 | Early detection | 0.003 |
| Performance | 0.003 | Disturbance | 0.003 |
| Value | 0.003 | Breeding | 0.003 |
| Breeding | 0.003 | Kimchi stuff | 0.003 |
| Leave of absence | 0.002 | Farmhouse | 0.003 |
| Parliamentary law | 0.002 | Commute | 0.003 |
| Commute | 0.002 | Applying correspondingly | 0.003 |
| Basic pay | 0.002 | Session | 0.003 |
| Form | 0.002 | Sister | 0.002 |
| Applying correspondingly | 0.002 | Siblings | 0.002 |
| Session | 0.002 | Influence of anger | 0.002 |
| Staggered break | 0.002 | Upper body | 0.002 |
| Confinement | 0.002 | Tragedy | 0.002 |
| Call | 0.002 | Confined | 0.002 |
| Prison officer | 0.002 | Call | 0.002 |
| Metal | 0.002 | Metal | 0.002 |
| Bell | 0.002 | Bell | 0.002 |
| Offense | 0.002 | Offense | 0.002 |
| Authentic | 0.002 | Authentic | 0.002 |
| Early detection | 0.002 | Limb | 0.002 |
| Disturbance | 0.002 | Geothermal heat | 0.002 |
| Geothermal heat | 0.002 | Drive | 0.002 |
| Kimchi stuff | 0.002 | Announcer | 0.002 |
| Upper body | 0.001 | Brother | 0.002 |
| Tragedy | 0.001 | Weighing | 0.002 |
| Drive | 0.001 | Motegi | 0.002 |
| Weighing | 0.001 | Performance | 0.002 |
| Motegi | 0.001 | Value | 0.002 |
| Oriental melon | 0.001 | Oriental melon | 0.002 |
### Table 2: Connectivity and positional center of keywords related to post-traumatic stress disorder

|   | DC    | EC     |   |
|---|-------|--------|---|
| 1st| Limb  | 11286  | 1st| Limb | 0.999 |
| 2nd| Announcer | 11153 | 2nd| Announcer | 0.99 |
| 3rd| Sister | 11115  | 3rd| Sister | 0.988 |
| 4th| Siblings | 11115 | 4th| Siblings | 0.988 |
| 5th| Influence of anger | 10261 | 5th| Influence of anger | 0.947 |
| 6th| Brother | 9757  | 6th| Brother | 0.898 |
| 7th| Performance | 9517 | 7th| Performance | 0.88 |
| 8th| Stock | 8914  | 8th| Stock | 0.857 |
| 9th| Pig | 8914  | 9th| Pig | 0.857 |
| 10th| Farmhouse | 8914 | 10th| Farmhouse | 0.857 |
| 11th| Helicopter | 8693  | 11th| Value | 0.841 |
| 12th| Value | 8693  | 12th| Helicopter | 0.841 |
| 13th| Live broadcast | 8421 | 13th| Live broadcast | 0.82 |
| 14th| Imprisonment | 8172  | 14th| Imprisonment | 0.786 |
| 15th| Farm | 8149  | 15th| Farm | 0.785 |
| 16th| Secretariat | 7951  | 16th| Secretariat | 0.77 |
| 17th| Sick leave | 7869  | 17th| Sick leave | 0.763 |
| 18th| Detention center | 7869  | 18th| Confinement | 0.763 |
| 19th| Application | 7869  | 19th| Bell | 0.763 |
| 20th| Confinement | 7869  | 20th| Application | 0.763 |
| 21st| Metal | 7869  | 21st| Detention center | 0.763 |
| 22nd| Bell | 7869  | 22nd| Metal | 0.763 |
| 23rd| Commute | 7156  | 23rd| Breeding | 0.704 |
| 24th| Applying correspondingly | 6951  | 24th| Geothermal heat | 0.686 |
| 25th| Session | 6951  | 25th| Commute | 0.666 |
| 26th| Call | 6951  | 26th| Session | 0.651 |
| 27th| Offense | 6951  | 27th| Applying correspondingly | 0.651 |
| 28th| Authentic | 6951  | 28th| Offense | 0.651 |
| 29th| Breeding | 6819  | 29th| Authentic | 0.651 |
| 30th| Geothermal heat | 6589  | 30th| Call | 0.651 |
| 31st| Kimchi stuff | 5441  | 31st| Kimchi stuff | 0.541 |
| 32nd| Drive | 5441  | 32nd| Drive | 0.541 |
| 33rd| Oriental melon | 5441  | 33rd| Oriental melon | 0.541 |
| 34th| Motegi | 5332  | 34th| Motegi | 0.536 |
| 35th| Solitary confinement | 4025  | 35th| Prisoner | 0.394 |
| 36th| Standing orders | 4025  | 36th| Weighing | 0.394 |
| 37th| Prisoner | 4025  | 37th| Leave of absence | 0.394 |
| 38th| Annual expense | 4025  | 38th| Disturbance | 0.394 |
| 39th| Workplace | 4025  | 39th| Annual expense | 0.394 |
| 40th| Leave of absence | 4025  | 40th| Parliamentary law | 0.394 |
| 41st| Parliamentary law | 4025  | 41st| Basic pay | 0.394 |
| 42nd| Basic pay | 4025  | 42nd| Early detection | 0.394 |
| 43rd| Form | 4025  | 43rd| Standing orders | 0.394 |
| 44th| Staggered break | 4025  | 44th| Workplace | 0.394 |
| 45th| Prison officer | 4025  | 45th| Form | 0.394 |
| 46th| Early detection | 4025  | 46th| Prison officer | 0.394 |
| 47th| Disturbance | 4025  | 47th| Upper body | 0.394 |
| 48th| Upper body | 4025  | 48th| Tragedy | 0.394 |
| 49th| Tragedy | 4025  | 49th| Solitary confinement | 0.394 |
| 50th| Weighing | 4025  | 50th| Staggered break | 0.394 |
Table 3: Types of factors related to post-traumatic stress disorder based on CONCOR analysis

| Cluster Name                | keyword                                                                 |
|-----------------------------|-------------------------------------------------------------------------|
| Cluster 1 Crops             | Drive, Kimchi stuff, Oriental melon                                     |
| Cluster 2 Broadcasting accidents | Announcer, Helicopter, Influence of anger, Live broadcast, Motegi       |
| Cluster 3 Farm livestock accidents | Breeding, Farm, Farmhouse, Pig, Stock, Value                            |
| Cluster 4 Various accidents | Parliamentary law, Workplace, Limb, Prisoner, Offense, Commute, Authentic, Disturbance, Basic pay, Applying correspondingly, Call, Session, Form, Imprisonment, Leave of absence, Brother, Upper body, Sick leave, Solitary confinement, Weighing, Annual expense, Secretariat, Metal, Application, Siblings, Confinement, Early detection, Performance, Prison officer, Sister, Bell, Detention center, Tragedy, Standing orders, Staggered break |

Figure 2: Clustering keywords related to post-traumatic stress disorder

Figure 3: Visualization of CONCOR analysis results for keywords related to post-traumatic stress disorder
DISCUSSION

The purpose of this study was to derive keywords from PTSD newspaper articles and to examine the relationship structure between words through semantic network analysis using the derived keywords. 11,304 articles on PTSD reported by four major Korean newspapers for three years from July 30, 2017, to July 30, 2020, were analyzed. The main results of the study are summarized and discussed as follows.

Deriving 50 keywords with high TF-IDF values in newspaper articles related to PTSD, TF-IDF values were high in the order of ‘Sick leave’, ‘Solitary confinement’, ‘Detention center’, ‘Standing order’ and ‘Prisoner’, indicating mostly mentioned PTSD words related in our society. Noting the most important word ‘sick leave’, many of the PTSD newspaper articles discuss the office workers’ use of sick leave due to mental illness and the following social atmosphere of Korea. Post-traumatic stress disorder has a high prevalence of depressive disorder, they are highly likely to experience depression due to traumatic events exposed during work or daily life. In a study on the depression of Korean office workers, even though 7.4% of office workers suffer from PTSD, the rate of using sick leave was 31%, which is significantly lower than the rate of using sick leave in Europe, 51%13. The reason behind this is the prevalent social atmosphere in Korea hiding depression at work due to treating depressed emotions as personal problems such as weak willingness. Depression, closely related to productivity in the workplace, needs to be properly managed in terms of manpower management, creating a social atmosphere so that physical and mental illness could be treated early through active use of sick leave.

Examining the roles and status of keywords in the network through centrality analysis, ‘Announcer’, ‘Influence of anger’, ‘Stock, ‘Pig’, ‘Farmhouse’ were keywords showing relatively high DC and EC values compared to TF-IDF values. Among them, ‘Announcer’ and ‘Influence of anger’ had great influence within the keyword network related to PTSD and played a major role in connecting other words. The result shows that post-traumatic stress is related to various accidents and is mentioned by announcers through the media. Among the various causes of PTSD, post-traumatic stress is highly connected with violent crimes caused in a fit of anger such as sexual harassment, murder, and violence. Studies reported that criminal damage is much more likely to cause PTSD than disasters or traffic accidents, and the lifetime prevalence is 38-39% for victims of assault cases, 30-35% for rape victims, and 20-30% for families with murder14-16. Accordingly, strategies supporting victims such as a recovery support program or protection system for PTSD, the psychological sequelae of crime victims, need to be further strengthened, and national support should be essentially expanded to ensure mediation for not only victims but also their families.

Conducting CONCOR analysis determining subgroups, the keywords related to PTSD were largely classified into four subgroups. The analysis shows that various factors of PTSD discussed in newspaper articles are divided into several types. Based on the keywords included in each cluster, the researcher named clusters as ‘PTSD by crops accidents’ (cluster 1), ‘PTSD by broadcasting accidents’ (clusters), ‘PTSD by farm livestock accidents’ (cluster 3), and ‘PTSD by various accidents’ (cluster 4). As clusters were classified into four categories according to the detailed type, all of the classified words are related to disasters and accidents, PTSD is closely related to various accidents occurring in society including disasters. Due to rapid changes in Korea, natural disasters such as earthquakes and floods, as well as various human and social disasters threatening, such as fire, gas explosion, and collapse of buildings, are occurring in succession. Besides, there were pandemics, one country affecting the rest of the world, such as MERS in 2002 and COVID-19 in 2020.17 In both natural and human disasters, the psychiatric disorder most experienced by victims is PTSD with 30-40% of direct victims and 5-20% of indirect victims such as rescue workers after a disaster.18 Therefore, we need to focus not only on the prevention strategies for disasters and accidents but also on the preparation of support and intervention plans and policies helping the recovery of victims. For example, it is believed that specific policy level activities are necessary, such as selecting a high-risk-PTSD group and receiving psychological first aid first for disaster victims or people working in dangerous occupational groups such as police officers and firefighters. Active research by experts should be conducted to identify the individual factors of those vulnerable to mental health problems caused by disasters and accidents and to specifically prepare policies for psychological support at the national level such as mandatory mental health check once every few months, compulsory installation of anonymous bulletin boards at work, etc. We confirmed keywords and centrality in PTSD newspaper articles,
but it is limited, and could not identify the context and sensitivity of the words. Follow-up study applying the emotional analysis technique to analyze the context used PTSD-related keywords is necessary.

**CONCLUSION**

This study examined keywords related to PTSD, centrality, and subclassification within the network through semantic network analysis using newspaper article big data. We confirmed the necessity of forming a social atmosphere for the active use of sick leave for psychiatric diseases such as PTSD. The study was meaningful as suggesting the need for post-traumatic stress to be managed nationally based on the results arguing specific strategies supporting mental health recovery for crime victims and their families, and policies responding to mental health problems caused by disasters and accidents should be prepared in detail.

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