

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.¹ 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.²⁻⁴ 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

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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.⁵ 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.⁶ 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>).⁷

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.⁸ 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.⁹ 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.¹⁰ 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.¹¹ CONCOR can identify keywords' clusters by classifying the top 50 extracted words related to post-traumatic stress disorder into subgroups.¹²

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”.

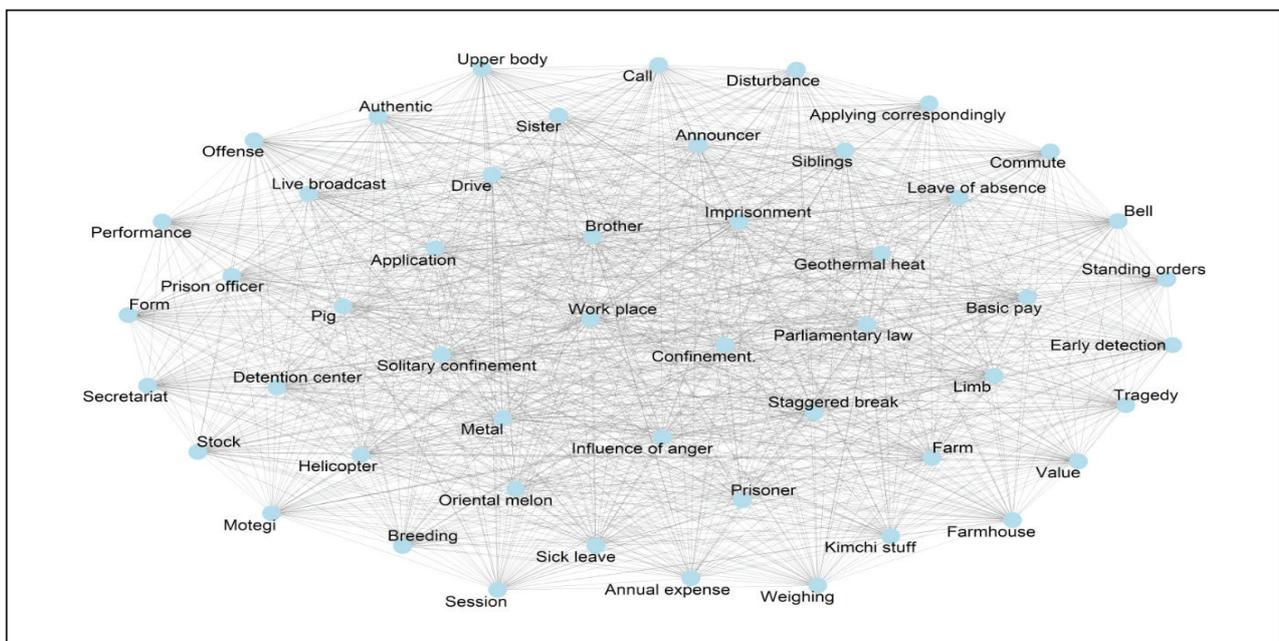


Figure 1: Full network visualization of keywords

Table 1: TF and TF-IDF (top 50) of words appearing in post-traumatic stress disorder documents

TF			TF-IDF		
1st	Sick leave	0.019	1st	Sick leave	0.021
2nd	Detention center	0.013	2nd	Solitary confinement	0.016
3rd	Limb	0.011	3rd	Detention center	0.014
4th	Announcer	0.011	4th	Standing orders	0.013
5th	Secretariat	0.01	5th	Prisoner	0.01
6th	Imprisonment	0.009	6th	Annual expense	0.009
7th	Solitary confinement	0.009	7th	Secretariat	0.007
8th	Standing orders	0.007	8th	Workplace	0.007
9th	Stock	0.007	9th	Live broadcast	0.006
10th	Helicopter	0.006	10th	Application	0.005
11th	Sister	0.006	11th	Stock	0.005
12th	Siblings	0.006	12th	Leave of absence	0.004
13th	Pig	0.006	13th	Parliamentary law	0.004
14th	Prisoner	0.005	14th	Basic pay	0.004
15th	Farm	0.005	15th	Form	0.004
16th	Influence of anger	0.005	16th	Staggered break	0.004
17th	Live broadcast	0.005	17th	Helicopter	0.004
18th	Application	0.009	18th	Pig	0.004
19th	Annual expense	0.005	19th	Farm	0.004
20th	Brother	0.005	20th	Imprisonment	0.004
21st	Farmhouse	0.004	21st	Prison officer	0.003
22nd	Work place	0.004	22nd	Early detection	0.003
23rd	Performance	0.003	23rd	Disturbance	0.003
24th	Value	0.003	24th	Breeding	0.003
25th	Breeding	0.003	25th	Kimchi stuff	0.003
26th	Leave of absence	0.002	26th	Farmhouse	0.003
27th	Parliamentary law	0.002	27th	Commute	0.003
28th	Commute	0.002	28th	Applying correspondingly	0.003
29th	Basic pay	0.002	29th	Session	0.003
30th	Form	0.002	30th	Sister	0.002
31st	Applying correspondingly	0.002	31st	Siblings	0.002
32nd	Session	0.002	32nd	Influence of anger	0.002
33rd	Staggered break	0.002	33rd	Upper body	0.002
34th	Confinement	0.002	34th	Tragedy	0.002
35th	Call	0.002	35th	Confinement.	0.002
36th	Prison officer	0.002	36th	Call	0.002
37th	Metal	0.002	37th	Metal	0.002
38th	Bell	0.002	38th	Bell	0.002
39th	Offense	0.002	39th	Offense	0.002
40th	Authentic	0.002	40th	Authentic	0.002
41st	Early detection	0.002	41st	Limb	0.002
42nd	Disturbance	0.002	42nd	Geothermal heat	0.002
43rd	Geothermal heat	0.002	43rd	Drive	0.002
44th	Kimchi stuff	0.002	44th	Announcer	0.002
45th	Upper body	0.001	45th	Brother	0.002
46th	Tragedy	0.001	46th	Weighing	0.002
47th	Drive	0.001	47th	Motegi	0.002
48th	Weighing	0.001	48th	Performance	0.002
49th	Motegi	0.001	49th	Value	0.002
50th	Oriental melon	0.001	50th	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

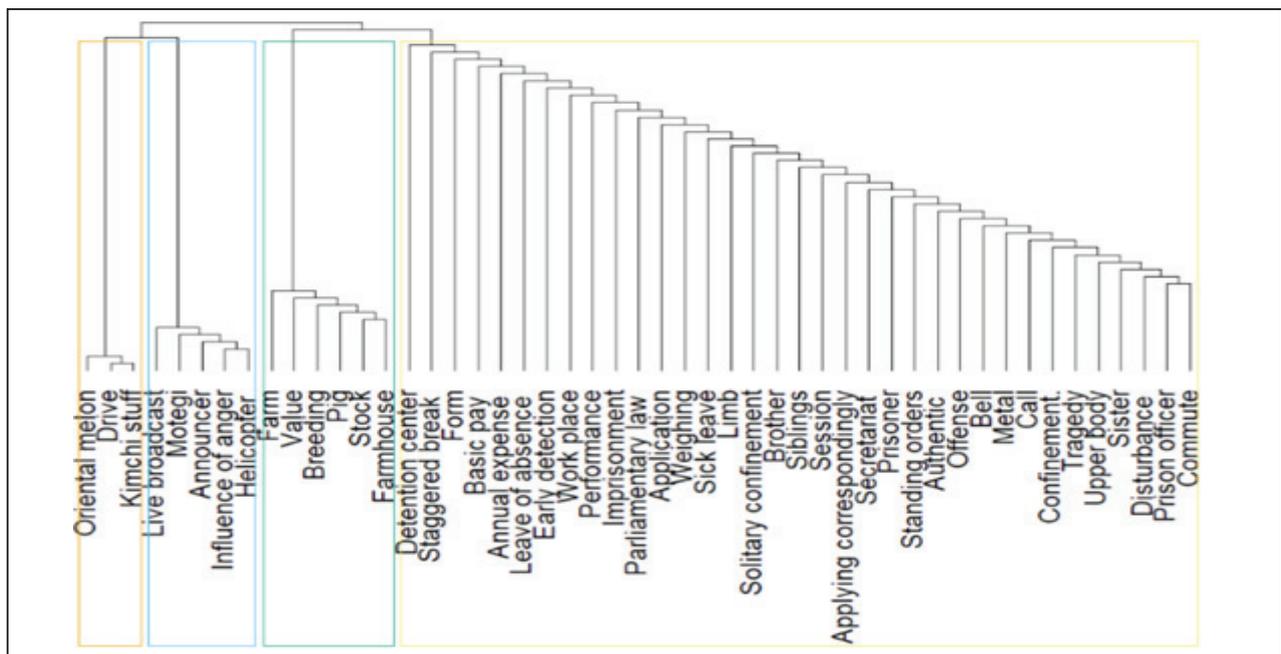


Figure 2: Clustering keywords related to post-traumatic stress disorder

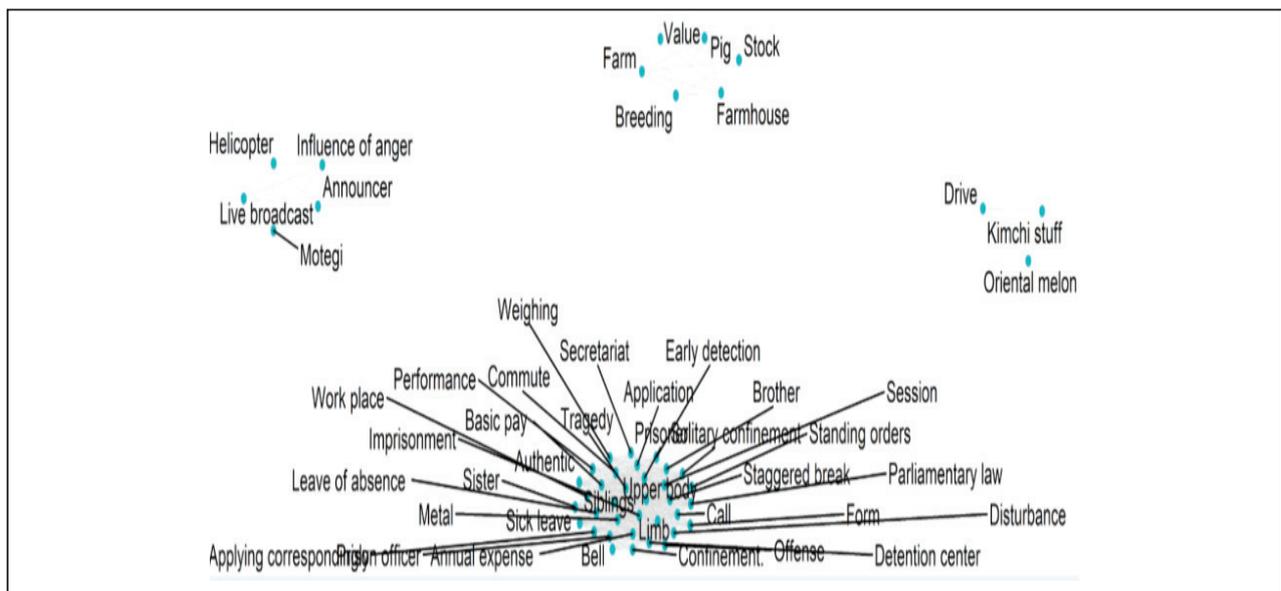


Figure 3: Visualization of CONCOR analysis results for keywords related to post-traumatic stress disorder

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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