[Original Article]

Functional and safety considerations in patient clothes during pandemic
- An infodemiological network analysis and LDA topic modeling -

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Abstract

This study analyzes the discourse of Korean internet users regarding patient clothing and identifies the changes to structure and content of clothing resulting from infectious disease outbreaks. The analysis draws on texts from Korean blogs, internet cafes, and news articles from 2011 to 2021 related to patient clothing. Using Ucinet 5 and NodeXL 1.0.1 programs, network density, centrality, and cluster analyses were conducted using the Wakita–Tsurumi algorithm. Additionally, Latent Dirichlet Allocation (LDA) topic modeling was applied using Python 3.7 to further explore thematic patterns within the discourse. Throughout the period of study, it was found that users consistently discussed the specific purpose and functionality of patient clothing. Following the outbreak of COVID-19, the distribution and influence of keywords related to the functional aspects of patient clothing, such as "hygiene and safety," significantly increased. An increased focus was placed on elements such as functionality, activity, autonomy, hygiene, and safety during the pandemic as public health concerns grew. It can be seen that patients increasingly share their experiences online and hospitalization rates surge during health crises; this study provides valuable insights into how the design of patient clothing can be improved through various informatics techniques. It underscores the evolving perception of patient clothing as essential medical equipment during health emergencies. In addition, it offers practical guidance for enhancing designs that better reflect shifting societal concerns, particularly regarding health, safety, and patient comfort.

Keywords: COVID-19, structural and content changes, patient clothes, social network analysis, LDA topic modeling

I. Introduction

As competition grows in the medical sector, hospitals prioritize patient-centered

care. Patients seek human-centered medical services, emphasizing technology, reliability, accessibility, reciprocity, and a positive hospital environment (Woodside, Frey, & Daly, 1989). Patient clothes plays a crucial role in enhancing medical services and patient satisfaction (Chung & Lee, 2010). Additionally, patient clothes serves as a form of medical service, providing information about the hospital and the patient's treatment needs (Liu et al., 2016).

Patient clothes warrants careful consideration as it significantly impacts patients' mental and physical healing (Lucas & Dellasega, 2020). For instance, it can shield both patients and healthcare workers from infectious substances (Granzow, Smith, Nichols, Waterman, & Muzik, 1998) and enhance treatment effectiveness by stabilizing the patient's mental and physical state, aiding recovery from fatigue (Vaskooi-Eshkevari, Mirbazegh, Soltani-Kermanshahi, Sabzali-Poursarab-Saeedi, & Alipour, 2019). However, wearing such attire may also reinforce patients' awareness of illness (Morton, Cogan, Kornfält, Porter, & Georgiadis, 2020) and evoke feelings of vulnerability (Jankovska & Park, 2019), potentially lowering self-esteem and contributing to a negative hospital experience (Lucas & Dellasega, 2020).

Despite their importance to patients, patient clothes has received less attention in academia compared to medical technology and other services (Cogan, Morton, & Georgiadis, 2019; Wellbery & Chan, 2014). While studies on patient clothes satisfaction (Jankovska & Park, 2019; Lucas & Dellasega, 2020) and design (Black & Torlei, 2013; Gordon & Guttmann, 2013) exist, there's a lack of user-focused exploratory research. Given that patients wearing such clothes may be vulnerable, there's a need for more active research on patient needs. Hence, this study focuses on public discourse about patient clothes to advance patient-centered services.

In infectious diseases like COVID-19, MERS, and SARS, the demand for negative pressure isolation wards rises swiftly to isolate and treat patients. With the increasing number of patients, the demand for patient clothes also rises. Despite active research on personal protective equipment (PPE) like protective clothes and face masks in the context of COVID-19 (Uddin et al., 2022; Wong, Bhyat, Srivastava, Lomax, & Appireddy, 2021), research on patient clothes remains limited. Previous studies (Choi & Lee, 2020; Ha, 2022) have shown that consumer perceptions of face masks evolved during the pandemic. Hence, perceptions of patient clothes, also medical wear, may have changed due to COVID-19.

This study investigates consumer discourse on patient clothes to identify structural and content changes resulting from infectious disease outbreaks. The research questions are as follows: (1) What distinct characteristics does discourse on patient clothes possess compared to daily wear? (2) How have discourse topics on patient clothes shifted with the COVID-19 outbreak? (3) Have specific topics seen an increase in discourse post-outbreak? By addressing these questions, the study aims to inform the design of patient-centered medical services, identifying areas to enhance patient clothes and suggesting future design directions.

Ⅱ. Literature Review

1. Prior research on the function of patient clothes

Well-fitting patient clothes with an appealing design has been shown to significantly enhance patients' positive perception (Vaskooi-Eshkevari et al., 2019). Conversely, unsatisfactory characteristics such as poor design and fit can negatively impact patients' self-esteem, identity, and motivation, leading to a negative hospital experience (Lucas & Dellasega, 2020). Therefore, to support patients' mental and physical healing, patient clothes should be tailored to their needs. Several studies, such as those by Jankovska and Park (2019), have analyzed dissatisfaction factors with existing patient clothes to inform the design of user-centered alternatives.

Patient clothes's size, design, and silhouette significantly influence patient satisfaction (Lucas & Dellasega, 2020). Research by Jankovska and Park (2019) indicates that women and older patients prefer loose silhouettes and ample body coverage. Patients have identified attractive design and well-fitting size as crucial aspects of patient clothes (Kwan, Hardy, & Siegel, 2021). Moreover, patient clothes should provide sufficient back width and length for comfortable lying down, with minimal seams to enhance comfort (Hwang, Song, & Song, 1998).

Notably, patient clothes also affect the patient's movement and activity level (Despond, Buchser, Sprunger, & Sloutkis, 1999), which are essential factors in determining consumer satisfaction with patient clothes (Powell, 2004). Patient clothes should be designed so that patients can receive treatment and care effectively, in comfort, and without interference with body movements (Kernaleguen, 1978). In particular, during hospitalization, patient clothes should be considered adjustments to general daily activities, such as walking, lying down, and bending (Jankovska, 2015).

In addition to ensuring mobility, enabling patients to change clothes easily and independently is crucial in patient clothes design. Previous studies highlight that many patients encounter difficulties with wearing patient clothes (Cogan et al., 2019). Researchers stress the importance of appropriately sized patient clothes for convenient operation and easy fastening and detachment (Chang, 2010). Moreover, the ease of opening patient clothes is essential for patients to quickly don and doff them, thereby preserving mobility (Hwang et al., 1998; Kwan et al., 2021).

Initially, patient clothes was introduced to ensure all patients wore suitable attire and to uphold hospital hygiene standards (Pesonen, Koskimies, Rapola, & Jääskeläinen, 1980). Hygiene remains a functional requirement for patient clothes (Hwang, Song, & Song, 1998; Topo & Iltanen-Tähkävuori, 2010), necessitating designs that defend against germs (Bae, Park, Ryou, & Jeong, 2008). Additionally, patient clothes fabrics

must withstand frequent washing and laundry chemicals, remaining durable without shrinking or wrinkling post-laundry (Park, Ryou, & Bae, 2006).

2. Effect of the pandemic on the patient clothes discourse

A pandemic is the highest level of warning for infectious diseases, as declared by the World Health Organization, and represents a state in which an infectious disease is prevalent worldwide (Choi & Lee, 2020). Recent epidemics include severe acute respiratory syndrome (SARS) in 2003, Middle East respiratory syndrome (MERS) in 2015, and COVID-19 in 2019. For these three cases, the basic reproductive number (i.e., the average number of people infected by one infected person) is higher for COVID-19 (2.0−2.5) than both SARS (1.7−1.9) and MERS (less than 1) (Petrosillo, Viceconte, Ergonul, Ippolito, & Petersen, 2020), which is why COVID-19 has greatly concerned medical staff and patients (De Pablo et al., 2020).

A related study (Heo, Nam, Jeong, & Kim, 2021) on patient behavior found that COVID-19 patients exhibit significantly higher intentions for social distancing compared to the general public, medical workers, and patient caregivers. The fear of COVID-19 can be likened to terrorism (Alebiosu, Ogundokun, & Raji, 2021) and can influence patients' attitudes and behaviors toward healthcare (Deliba et al., 2020; Hoyer et al., 2021; Moynihan et al., 2021). Patient clothes is closely tied to patients both physically and mentally. Despite active research on PPE (personal protective equipment) like protective clothes and face masks during COVID-19 (Karim et al., 2020; Uddin et al., 2022), studies on the relationship between infectious diseases and patient clothes are lacking.

Regarding clothes behavior and pandemics, there are studies on changes in consumer perceptions of general fashion for the epidemics of SARS, MERS, and COVID-19 (Choi & Lee, 2020). While fashion-related topics did not include infectious disease con-

tent when SARS and MERS were prevalent, during the COVID-19, infection and prevention have emerged as significant issues in fashion-related topics, as people feel more anxious, and this is reflected in fashion.

We encountered discussions on patient clothes in various studies, albeit partially. Regarding activity, some studies advocate for patient clothes that allows a reasonable range of motion, particularly in the context of non-face-to-face COVID-19 treatment (Wong et al., 2021). They argue that since physical manipulation is necessary in virtual treatment scenarios, patient clothes should be redesigned to accommodate patients' activity levels. Other studies (Hangulu & Akintola, 2017) underscore the importance of hygiene management and disposal of patient clothes during epidemics. However, these studies primarily focus on PPE management, lacking discussion on patient clothes from the wearer's perspective.

Social big data analysis extracts insights and opinions from diverse sources, predicting social issues and revealing complex relationships (Song & Song, 2016). It offers novel information not obtainable through traditional methods like surveys. Network analysis and topic modeling are common in this approach, including discourse analysis on infectious diseases (Ahmed, Vidal-Alaball, Downing, & Seguí, 2020; Boon-Itt & Skunkan, 2020). This study explores the discourse of the Korean public on patient clothes during an epidemic using social big data analysis.

Ⅲ. Methodology

1. Social network analysis

Social network analysis (SNA) is a method of analysis that examines the characteristics of networks and elucidates system features through the relationships or behaviors of constituent units (Wasserman & Faust, 1994). When applied to discourse, SNA focuses on emergent properties resulting from keyword relationships, rather than analyzing each keyword individu-

ally, thereby emphasizing the relational aspect of discourse. Utilizing SNA enables the identification of relational structures that statistical methods may overlook, allowing for the derivation of new insights visually (Knoke & Yang, 2008).

The subject of analysis in this study is non-human, unstructured text data. Analysis of such data is called "semantic network analysis," which applies messages, instead of people, to the SNA method (Mitchell, 1969). Semantic network analysis is a method to derive characteristics for a specific topic by detecting the edge strength and regularity between texts for the frequency and co-occurrence of words (Park & Leydesdorff, 2004). Since the subject of this study is text generated by the public, SNA was also applied.

The positions occupied by nodes (i.e., keywords) within a network can be expressed through their centralities (Freeman, 1978). The centrality measure, often used to indicate a node's influence, represents how frequently a word is linked to other words (Kwahk, 2014). Nodes with elevated betweenness centrality function as connectors, facilitating interactions between distinct clusters of nodes within the network (Bavelas, 1950). In addition, closeness and eigenvector centrality can be used as analysis measures (Freeman, 1978).

2. LDA topic modeling

Topic modeling is a widely used analytical technique for data evaluation. It estimates the likelihood of a word being associated with a topic and the joint probability of that topic occurring in a document (Choi, Yoon, Xuan, Lee, & Lee, 2021). Latent Dirichlet Allocation (LDA) is a statistical algorithm for topic modeling. It predicts related words of a topic by assuming that documents with similar word distributions share similar topics (Blei, Ng, & Jordan, 2003).

Topic modeling is a statistical algorithm uncovering embedded topics in large, unstructured document sets. Expert assistance isn't needed due to its reliance

on mathematical principles describing document gene-ration (Biel, 2012). The Latent Dirichlet Allocation (LDA) method is widely used, assuming each word in a document has a probability distribution for a set of topics, composing each document accordingly (Blei et al., 2003). For a detailed discussion of LDA topic modeling in the social sciences, see Jelodar et al. (2019).

LDA topic modeling is a methodology used in various academic fields to investigate the correlation between specific topics and the change in these topics over time. In a study using topic modeling, Park et al. (2021) analyzed the public discourse on COVID-19 in four Asian countries with outbreaks of varying severity: Korea, Iran, Vietnam, and India. A number of other studies (Abd-Alrazaq, Alhuwail, Househ, Hamdi, & Shah, 2020; Boon-Itt & Skunkan, 2020; De Melo & Figueiredo, 2021) have analyzed the public perception of the COVID-19 pandemic. In this study, LDA topic modeling analysis is used to investigate changes in the discourse on patient clothes.

3. Data collection and analysis

In order to understand the opinions of Korean users on patient clothes, this study used text data extracted from Korean social media. News articles, blog posts, and cafe posts containing "patient clothes" as a keyword were collected from Naver and Daum. Naver and Daum, two of South Korea's most pro-minent platforms, host millions of active users who engage in discussions on various topics. Most users in South Korea obtain news through these portals rather than directly from media outlets (Hyun, Jung, & Seo, 2020). These platforms provide abundant user-generated content through blogs and online communi-ties, while also aggregating news media, making them key resources for analyzing public perspectives and media framing of patient clothing issues.

The analysis period in this study was meticulously classified to assess the impact of epidemics on con-sumer discourse regarding patient clothing over an approximately ten-year period, from 2011 to 2021. The data was divided into four distinct periods based on major health-related events: the early stage (2011–2012), middle stage (2015–2016), late stage (2018–2019), and the COVID-19 pandemic stage (2020–2021). The early stage (2011–2012) serves as a base-line, representing the period before any major health crises. The middle stage (2015–2016) coincides with the MERS (Middle East Respiratory Syndrome) outbreak in South Korea, which may have heightened public awareness of healthcare and infection control, potentially influencing the discourse on patient clo-thing. The late stage (2018–2019) covers the time just before the COVID-19 pandemic, excluding the effects of MERS and COVID-19. Finally, the COVID-19 pandemic stage (2020–2021) reflects the global pan-demic's impact on discourse. The collected samples consist of 6,379 cases in the early stage, 7,341 in the middle stage, 7,251 in the late stage, and 6,808 during the pandemic.

Web crawling, text mining, and LDA topic model-ing were implemented through the Python 3.7 pro-gram. The UCINET6 program was used for centrality measure and structural hole analyses. The NodeXL 1.0.1 program was used for circular network visuali-zation and clustering analyses using the Wakita-Tsurumi algorithm. Finally, topic modeling was per-formed using the Gensim library in Python 3.7, and the results were visualized through the pyLDAvis module.

Before modeling the SNA and LDA topics in this study, it was necessary for the data to undergo a text mining process suitable for the Korean language. Text mining is the process of extracting useful information from unstructured data written in human language using natural language processing technology (Song & Song, 2016). In the case of the Korean corpus, tokenizing in units of morphemes is preferable to tokenizing in units of spaces as in English (Kang & Yang, 2018). In this study, the MeCab morpheme analyzer of KoNLPy, a Korean information process-

ing Python package, was used for Korean morpheme classification.

Mecab-ko is known as a model with good performance among morpheme analyzers and is open-source (Na, Jeon, Kang, Ahn, & Im, 2021). For the morphemes used in the preprocessing, only common nouns (NNG), proper nouns (NNP), and foreign languages (SL) with a word length of two or more characters were extracted and used. In order to remove meaningless words in the analysis, we created a stop words dictionary and performed additional processing. The stop words dictionary contains prepositions, temporal words, and commonly used words (i.e. people, person, hospital, and so on).

Ⅳ. Results

1. Differences in the discourses on daily wear and patient clothes during the epidemic

The content of discourse on clothes with a clear function, such as patient clothes, do not change significantly over time unlike daily wear. In other words, although the weight of individual (sub) discourses on patient clothes may vary, it is rare that existing discourses disappear or new discourses appear. In contrast, in the case of daily wears' keywords change sensitively over time due to the "fashion cycle" (Davis, 2013). Especially in the medical industry, since medical treatment is the main product, there is less room for management issues to reflect trends compared to other industries (Inn, 2008).

In this study, to determine whether the discourse on patient clothes is consistently discussed and centered on specific topics compared to daily wear, the discourses on patient wear and daily wear were each implemented as a network, and density analysis was conducted. The circular network is valuable for visually checking the relational structure and overall density between words (Regner et al., 2016). Therefore, in this study, discourses including "daily wear" were extracted from the same channel and for the same period as patient clothes and visually compared on a circular network. Accordingly, it is possible to distinguish the differences between the discourse networks of daily wear and patient clothes (Fig. 1 and 2).

The discourse on daily wear shows a large variation in density and edge strength (edge weight)
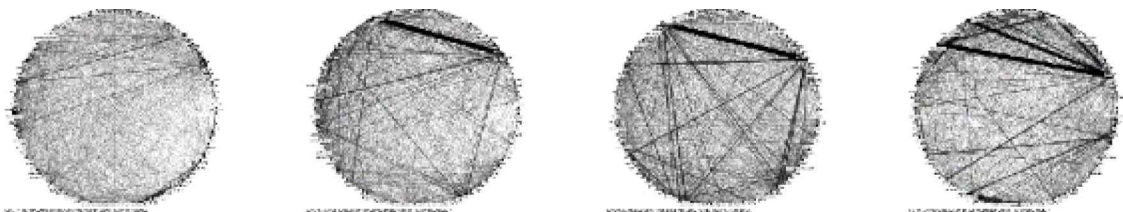
<Fig. 1> Changes in network density of patient clothes
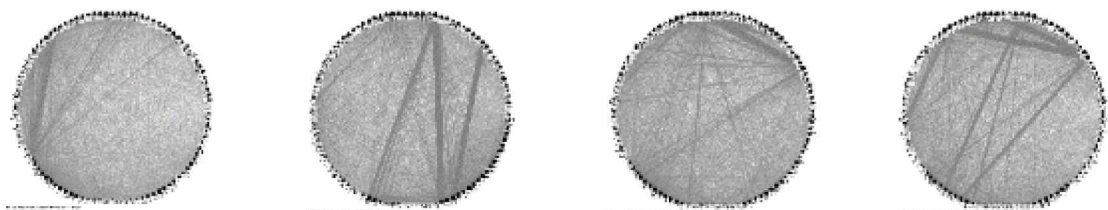
<Fig. 2> Changes in network density of daily wear
Note. From the left: 2011–2012, 2015–2016, 2018–2019, and COVID-19 (2020–2021).

between nodes over time. In contrast, the discourse on patient clothes shows similar density and edge strength distribution regardless of time. High density and high betweenness centrality indirectly suggest fewer structural holes (Burt, 1992; Kwahk, 2014). After measuring an average of betweenness centrality (Cb), daily wear was found to be Cb=11.070–18.520 and patient clothes to be Cb=14.870–18.530. The average mediating center difference by period was higher in the daily wear network; therefore, the patient wear network had higher density, mean of betweenness centrality, and structural holes (Table 1). These results mean that the discourse on patient clothes is consistently and continuously discussed with a specific structure.

Moreover, the discourse is consistent and continuous in terms of not only structure but also content. Comparing the top 100 keywords based on the frequency of their appearance in the discourse, 52% of the keywords appeared in common in all periods. Specifically, these were hospitalization conditions (i.e., surgery, testing, treatment, and childbirth), subjects, innerwear of patient clothes, cleanliness, daily activity (i.e., toilet, meal, self, and exercise), wearing and undressing, and negative emotions.

2. Changes in patient clothes discourse before and during the epidemic

The discourse on patient clothes is discussed within a limited subject, but the relationship or distribution of each sub-topic can vary depending on any particular event such as an epidemic. In the particular case of COVID-19, many studies have found that the outbreak has had a significant impact on consumer discourse (Park, Park, & Chong, 2020). Accordingly, this study examines whether any specific characteristics of patient clothes were more actively discussed during compared to before COVID-19.

1) Changes in the betweenness centrality of keywords

For determining how the proportion of topics in the discourse on patient clothes has changed, there is a method of tracking which words play a crucial role in a discourse. This study uses change in betweenness centrality to determine the role and position change of keywords. Betweenness centrality is an indicator that describes how much a keyword performs the role of a broker or gatekeeper (Abbasi et al., 2012). Therefore, if a keyword's betweenness centrality is high, it is likely to have influenced the flow of communication within the discourse (Kwahk, 2014).

In previous studies on patient clothes, functional factors in patient clothes included the autonomy of the clothes (Cogan et al., 2019; Kwan et al., 2021), the activity of daily life (Despond et al., 1999; Powell, 2004), and hygiene to ensure patient safety (Bae et al., 2008; Hwang et al., 1998; Park et al., 2006). This study classified the functional factors of patient clothes accordingly.

Through examining changes in the influence of keywords based on their betweenness centrality, it was found that the betweenness centrality (Cb) of keywords functional factors of patient clothes and related COVID-19 keywords increased (Table 2). For example, 'self' is a keyword related to autonomy, which is connected to other keywords indicating activity, such as wearing, undressing, and movement.

<Table 1> Average of structural holes

	2011–2012	2015–2016	2018–2019	COVID–19
Daily wear	44.319[a]	29.825	24.885	24.677
Patient clothes	42.017	43.639	40.667	45.544

[a] The value means the average of the structural hole of 100 nodes.

<Table 2> Betweenness centrality of patient clothes before and during COVID-19

2018−2019			COVID-19		
Rank	Word	Cb	Rank	Word	Cb
1	Wearing	46.91	1	COVID-19	50.32
2	Undressing	26.52	2	Wearing	47.72
3	Appearance	26.35	3	Change	42.10
4	Innerwear	26.12	4	Mask	36.06
5	Uncomfortable	25.19	5	Appearance	24.17
6	Protection	23.53	6	Undressing	24.12
7	Plain Clothes	23.49	7	Laundry	23.17
8	Color	14.08	8	Uncomfortable	23.11
9	Underwear	13.07	9	Innerwear	21.65
10	Design	12.23	10	Underwear	17.67
11	Change	11.89	11	Function	17.52
12	Size	11.81	12	Button	14.82
13	Laundry	10.48	13	Self	13.73
14	Movement	9.26	14	Size	12.58
15	Mask	6.91	15	Movement	11.56
16	Self	6.87	16	Design	10.08
17	Button	5.37	17	Activity	9.56
18	Activity	4.91	18	Safety	9.40
19	Fabric	4.78	19	Protection	7.63
20	Safety	5.95	20	Hygiene	7.12

The betweenness centrality of 'self' increased from C_b=5.13 to C_b=13.73 due to COVID-19. 'Activity' increased from C_b=4.91 to C_b=9.56. 'Laundry' increased from C_b=10.48 to C_b=23.17. 'Safety' increased from C_b=5.95 to C_b=9.40. 'Function' (C_b=17.52) and 'hygiene' (C_b=7.12) have appeared during COVID-19 as the primary keywords based on betweenness centrality.

The keywords 'change (the clothes)' and 'button' show a significant increase in betweenness centrality. Easy changing is an essential component of patient clothes; it increased from C_b=11.89 to C_b=42.10. 'Button' means opening clothes; it increased from

C_b=5.37 to C_b=14.82. Accordingly, this study found that the influence of keywords with functional properties has increased in the discourse on patient clothes during COVID-19.

2) Changes in distribution of subtopics and significance tests

This study uses LDA topic modeling to determine whether the discussion on a specific topic changed significantly with the outbreak of COVID-19. Quantitative indicators such as perplexity can be used when determining the number of topics, but perplexity is only an indicator that evaluates how well learning is

done from a modeling point of view and does not guarantee ease of interpretation (Lee & Lee, 2019). Therefore, in studies where topic interpretation is essential, it is recommended that domain experts qualitatively determine the most appropriate number of topics (Andrzejewski, Mulhern, Liblit, & Zhu, 2007).

In this study, three doctoral-level experts in clothes science and two doctoral-level experts in informatics participated in discussions to determine the number of topics and to define the topic names. As a result of examining the distribution of words by topic, it was judged that the explanatory power was the best when the number of topics was four (Table 3). The topic names were defined based on the keyword that occupies the highest proportion in the respective topic.

Topic 1, "Hygiene and safety," focuses on cleanliness and protection, particularly in COVID-19. Keywords such as "mask," "protective clothes," "disinfection," "hygiene," and "safety" emphasize the role of patient clothing in maintaining safety and preventing infection. Topic 2, "Autonomy and activity," explores the importance of independence and mobility in wearing and undressing patient clothing. Keywords like "change," "wearing," "movement," "self," and "activity" highlight the practical aspects of daily activities and autonomy. Topic 3, "Hospitalization and emotion," addresses the emotional experiences and psychological impact of hospitalization, using keywords such as "worry," "happiness," "recovery," "emergency room," and "bandage" to capture both emotional and physical aspects of patient experiences. Lastly, Topic 4, "Design and fit," focuses on the aesthetic and functional elements of patient clothing. Keywords such as "button," "size," "fabric," "pattern," and "design" highlight the importance of comfort and style in patient satisfaction.

Before the outbreak of COVID-19, topics 3 and 4 were mainly discussed; after the outbreak, topics 1 and 2 have been more discussed. To verify whether this increase is statistically significant, this study performed a statistical significance test on the difference in topic ratio between two-time points using the Bootstrap technique. The Bootstrap technique is a method to evaluate significance by estimating parameters through resampling and assuming that the given data is an independent sample representing the original population without the assumption of probability distribution (Efron, 1981). A simulation was conducted in which the discourse before and during COVID-19 was extracted as 1,000 bootstrap samples, and the ratio difference for each discourse was calculated and repeated 10,000 times.

The point estimates for the topics of each discourse are shown in Table 4, and, based on the simulation results, the ratio of each topic (including the 95%

<Table 3> Changes in topics per document before and during COVID-19

Topic	Attribution	Keywords
Topic 1	Hygiene and safety	COVID-19, infection, health, laundry, sheet, surgery gown, mask, isolation, work clothes, disinfection, white, detergent, protective clothes, blanket, prevention, safety, washing, hygiene, disposal, virus
Topic 2	Autonomy and activity	Change, wearing, injection, underwear, meal, textiles, sleep, pain, activity, undressing, uncomfortable, iv injection, toilet, movement, pants, life, self, one-piece dress, locker room, shower
Topic 3	Hospitalization and emotion	Worry, tear, life, hospitalization, emergency room, panty, legs, feeling, bandage, happiness, smile, innerwear, family, knee, recovery, ankle, shoes, underwear, anesthesia, cast
Topic 4	Design	Pants, gown, button, pajamas, size, one-piece dress, top, design, fabric, price, diaper, plain clothes, bottom, pocket, shoulder, pink, pattern, waist, cardigan, smell

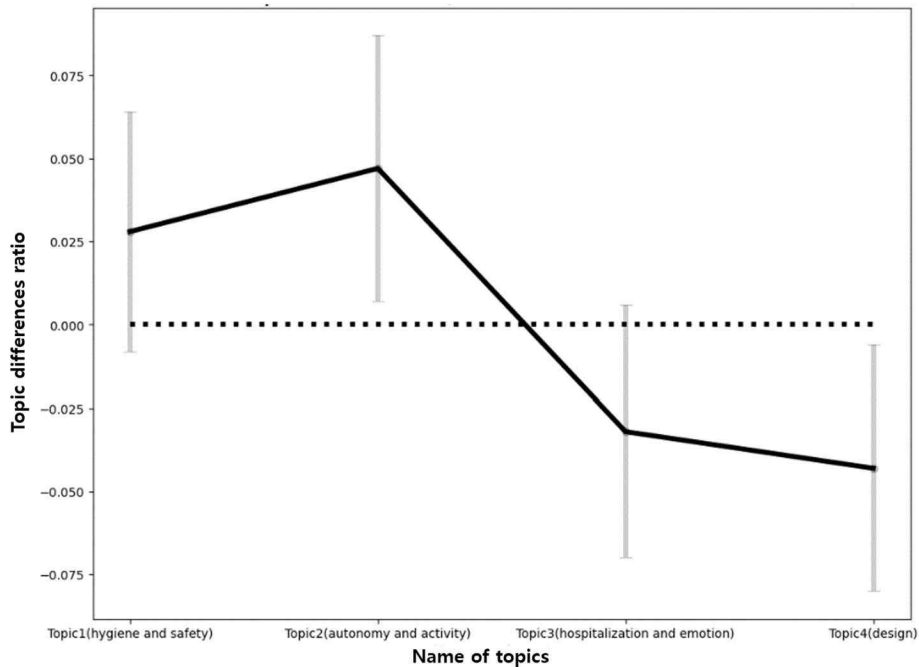<Table 4> Point estimates by topic (before and during COVID-19)

Period	Topic 1	Topic 2	Topic 3	Topic 4
Before COVID-19	0.197	0.288	0.259	0.255
During COVID-19	0.225	0.335	0.228	0.212

confidence interval) is shown in ⟨Fig. 3⟩. As seen in ⟨Fig. 3⟩, in the simulation, the distribution ratio for Topic 2 at the 95% confidence level increased significantly in the discourse with the outbreak of COVID-19. The distribution ratio for Topic 1 was not significant at the 95% confidence level, but a significant increase occurred at the 90% confidence level.

Therefore, it was found that the distribution ratios for Topic 1 (i.e., representing the hygiene and safety of patient clothes) and Topic 2 (i.e., representing the autonomy and activity of patient clothes) have increased statistically significantly in the discourse due to COVID-19 (Fig. 3), while the distribution ratios for Topic 3 (i.e., representing hospitalization situations and emotions) and Topic 4 (i.e., representing the mor-

phological factor of patient clothes) have decreased.

The patient's performance of daily activities, such as walking, lying down, and bending over, is related to the activity attribution of the patient's clothes (Jankovska, 2015; Kernaleguen, 1978). Therefore, the ease of wearing and undressing clothes is also a requirement for patient clothes (Cogan et al., 2019), which is related to securing patient autonomy (Hwang et al., 1998). In addition, safety and hygiene are functional requirements for patient clothes (Topo & Iltanen-Tähkävuori, 2010). The increase in Topic 1 and Topic 2 represents an increase in the discussion of functional requirements for patient clothes. This study found a statistically significant increase in the difference in topic distribution for functional charac-

<Fig. 3> Rate of Topic differences (before and during COVID-19)
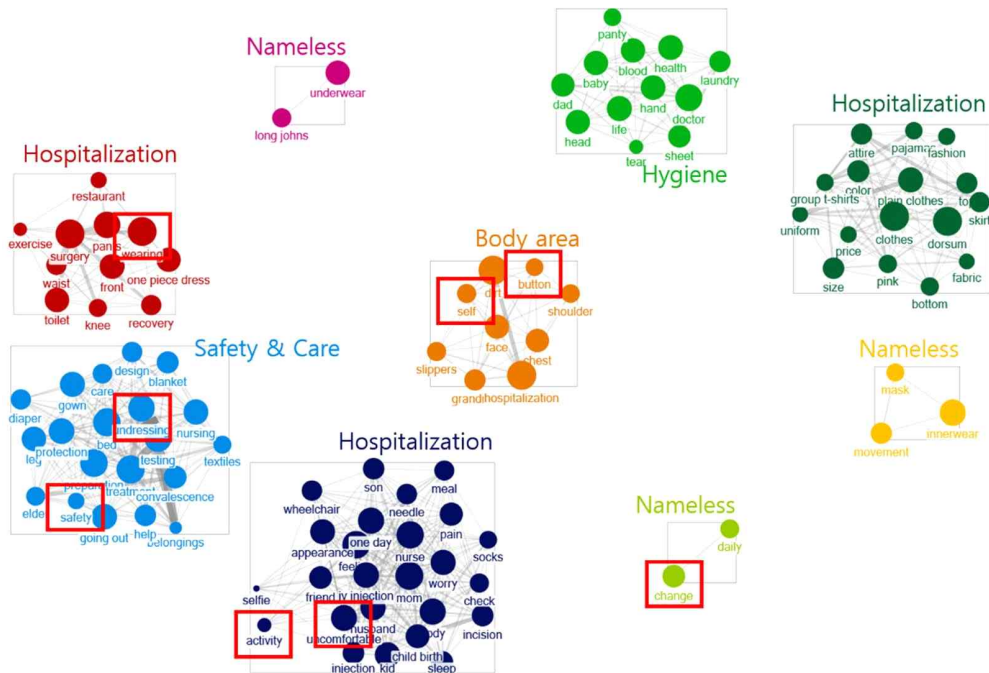
teristics (i.e., Topic 1 and Topic 2).

In order to visually confirm the results of topic modeling, the distribution changes of the functional topics of patient clothes due to COVID-19 were analyzed using cluster analysis. Several social science studies have proposed the Wakita−Tsurumi algorithm to explore which clusters (i.e., topics) are formed based on word relationships (Barros, Conejo, Ruiz-Sepulveda, & Triguero-Ruiz, 2021). The algorithm is used for finding community structures in mega-scale social networks (Wakita & Tsurumi, 2007). After clustering, nine clusters were formed before COVID-19, and seven were formed during COVID-19 (Fig. 4 and 5). Based on these clusters, we found that the discourse on patient clothes was discussed as a more limited topic about the pandemic and patient clothes' functional properties after the outbreak of COVID-19.
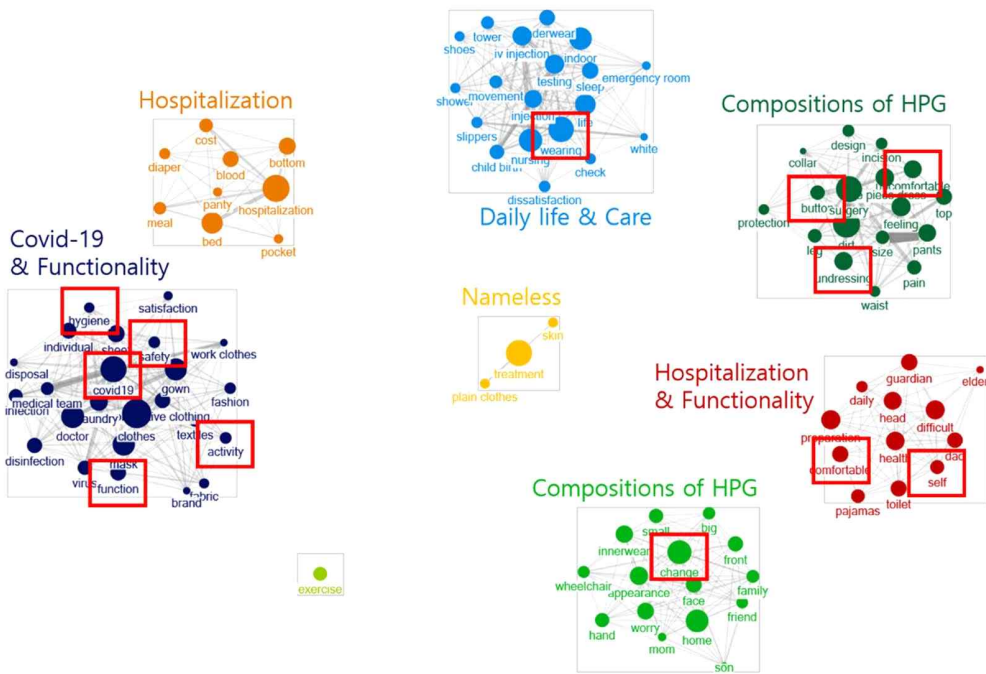
Groups with many nodes can be assumed to be the main topics for patient clothes. Before COVID-19, hospitalization and treatment were the most important topics. As keywords related to hospitalization situa-

tions and treatments were identified in most of the clusters, they were found with a wide distribution. On the other hand, during COVID-19, the pandemic situation, functionality (i.e., COVID-19, function, activity, safety, and hygiene), and factors of wearing and undressing patient clothes (i.e., button, comfortable, and undressing) appeared as the most important topics. Functional keywords that showed a broad distribution before the outbreak of COVID-19 were located in the same group as the pandemic situation topic after the outbreak.

Based on these results, in the context of COVID-19, this study confirms that functional factors are aggregated through infectious diseases. In other words, with the rapid spread of COVID-19, concerns about safety from infectious diseases have led to discussions about hygiene and protection, which suggests that the functional factors of patient clothes are discussed more as the number of people wearing patient clothes increases.

<Fig. 4> Patient clothes discourse before COVID-19

<Fig. 5> Patient clothes discourse during COVID-19

Ⅴ. Conclusion

This study used SNA and LDA topic modeling to determine how the Korean public's discourse on patient clothes changed with the outbreak of COVID-19. After observing the temporal change of the discourses on patient clothes and daily wear, there was a clear difference in the two discourse structures, even though both discourses are on clothes. The structure of the discourse on daily wear changed irregularly as time passed due to the influence of fashion. In contrast, patient clothes have a particular discourse structure and content that is continuously and consistently discussed.

This study found that the functional factors of patient clothes became more prominent as more people needed to wear patient clothes. Based on the difference in the distribution of words related to patient clothes before and during the epidemic, it is possible to obtain a topic (subject)-forming clue about the functional factors of patient clothes (i.e., autonomy,

activity, hygiene, and safety). The outbreak of COVID-19 represents a significant event that has led to discussions about the functional factors of patient clothes. People's concerns about safety due to COVID-19 have appeared as discussions about hygiene and protection in patient clothes.

This study provides an understanding of and insight into medical services by researching patient clothes in a pandemic when the number of people wearing patient clothes increases significantly. These results suggest that, before COVID-19, people recognized patient clothes as fashion worn in hospitals; however, during COVID-19, due to their anxiety about infection, patients recognize patient clothes as protective clothes. In other words, functional, such as autonomy and activity, rather than external factors have become more prominent in the discourse.

This study provides significant practical insights for healthcare providers and patient clothing manufacturers by analyzing consumer discourse on patient clothing. First, during the COVID-19 pandemic, the

demand for hygiene and safety in patient clothing became particularly prominent, highlighting the need for guidelines on material selection and maintenance methods. For example, the findings of this study can be applied to the development of protective and hygienic clothing made from materials and designs that effectively prevent infection. Second, considering the importance of ensuring patient autonomy and mobility, the comfort and functional design of patient clothing must be prioritized. These insights can be applied to the design of hospital attire that enhances patient mobility and comfort. Third, the emotional experiences of patients during hospitalization should be considered, leading to the development of design elements, such as color and pattern choices, that promote psychological stability.

Lastly, the study emphasizes that both the aesthetic appearance and functionality of patient clothing should be considered, driving practical improvements in the design of new medical garments that meet consumer demands for both design and comfort. Patient clothes should be designed with the 'good design' principle (Black, Kapsali, Bougourd, & Geesin, 2005) for physically and mentally vulnerable patients. In the future, whether in a pandemic situation or not, patient clothes must be functional, fit for purpose, and evolve in an aesthetically beautiful direction.

Since this study used social big data written by Korean users, the result is difficult to generalize to a wide range of global cases. In follow-up studies, it will be necessary to conduct research in various categories, such as comparing Asian countries' perceptions of patient clothes, perceptions by culture, comparison of people with and without disease, and comparison of doctors and patients. Additionally, to gain a deeper understanding of consumer perceptions and opinions, future studies should incorporate interviews or surveys to provide a more in-depth approach. Although this study focused on the functional factors of patient clothes, a different interpretation could have been derived, for example, from a medical point of

view. If researchers from various academic fields cooperate in conducting research in the future, it would be possible to derive more insightful results on patient clothes as a medical service.

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