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Social Perception Analysis of Skin Health Using Big Data

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As people's demands and interests in skin health increase, the skin beauty industry develops, and information shared through social media continues to expand. In this paper, we collect data through utilizing skin health keywords in Textom and conduct network analysis with Ucinet. Over the last two years (May 3, 2021 – May 3, 2023), a total of 4,386 data points were collected. Looking at the research results, first, as a result of analyzing the frequency of keywords related to skin health, collagen, product, management, use, improvement, melanin, aging, and cosmetics were ranked in the respective order. Second, by using NetDraw, it was possible to visualize the entire network structure of skin health and simultaneously identify the relationship between each keyword. Third, the analysis of degree centrality, closeness centrality, betweenness centrality, and eigenvector centrality suggest keywords such as product, management, and use play a central role in connecting other keywords. Fourth, as a result of the CONCOR analysis, it was possible to classify into four clusters: skin nutrition, skin stimulation, skin disease, and beauty tech in relation to skin health awareness. This study was able to look at the recent general awareness of skin health through online data, and it will be used for improving awareness of skin health, classifying consumers, and developing marketing strategies.

Keywords: Big data, Network analysis, Skin health, Social network.

1. Introduction

The skin is the outermost layer of the body that is in direct contact with the environment and protects the internal organs, thus playing an important role in maintaining the normal activity of the human body. In general, healthy skin means that the skin surface is moist, shiny, elastic, and has a clear skin color, but even healthy skin can be damaged by human physiology, external environment, and psychological factors (Park, 2014). In order to maintain healthy skin, a balanced supply of nutrients, the use of adequate cosmetics, and adequate exercise are necessary, which can maintain skin resistance to environmental stimuli (Yang & Seo, 2009).

Healthy skin increases confidence and satisfaction with one's appearance and has a positive effect on the quality of life (Ha & Kim, 2020). As the standard of living improves and the quality of life of individuals is emphasized, the interest and desire for a healthy and beautiful appearance also increase, and people today are strengthening positive psychological and social functions through skin care. Recently, the focus of health management is shifting from a

treatment-oriented concept to a concept for maintenance and promotion, and there is a trend toward daily and continuous management to improve and maintain skin health (Park, 2014). As people's demands and interest in skin health increase, the skin care industry is also rapidly developing (Park & Jeong, 2017). Inner Beauty, which cultivates healthy beauty from the inside of the body, is commercialized and the form of cosmetics and food (Kim, 2020), and skin care devices that can make professional care a daily routine at home developed. In particular, instead of receiving professional skin care at dermatology clinics and aesthetics, home beauty has become the new trend as self-beauty devices become more sophisticated and expensive (Park, 2020). In line with the 4th industrial revolution, masks and lifting machines that incorporate cutting-edge technologies such as AI and LED have had a great impact on the change in the skin care paradigm. BeautyTech is a compound word of beauty and technology, representing the convergence of beauty and IT. It will be expanded to consumer-customized technologies or products in line with beauty needs (Kim, 2022; Min et al., 2024; Maltare et al., 2023; Na and Na, 2024).

Currently, the beauty market is expanding consumption online, and social media based on social networks between individuals or groups is becoming the main communication method for sharing information by users such as product reviews, recommendations, and evaluations (Hwang et al., 2019). In particular, with the advancement of information and communication technology, online web data is rapidly generated and a vast amount of big data is formed. Recently, big data analysis has been used as a new approach to meaningfully look at related information. This method not only enables us to understand the phenomenon itself through the discovery of various correlations, but also supports a society in which assumptions and measurements of causal factors are limited. The phenomenon can be understood through large-scale case analysis (Jo, 2019). Recently, big data analysis has been conducted in the beauty field (Baek & Ju, 2021; Oh, 2022; Choi et al., 2022), but is still very incomplete with no big data research related to skin health. The analysis of big data in the beauty field will effectively used to identify consumers' perceptions and reactions and to establish product development and marketing strategies.

Therefore, this study aims to provide basic data on consumers' concept and perception of skin health and suggests implications by using unstructured big data related to skin health.

This study set the research question as follows.

RQ1: What are the main keywords related to skin health in web data for the last two years?

RQ2: What is the network structure of skin health examined through big data?

2. Literature Review

2.1. Skin health

Skin health refers to a skin with a fine skin texture, moist, elastic and shiny skin due to the balance of various biological processes of the skin and the promotion of metabolism and physiological activity to stimulate cell activity (Lee, 2006; Kim & Kim, 2009; Yang & Seo, 2009). Healthy skin facilitates functions such as body temperature regulation, internal organ protection, the secretion of protective substances, and vitamin D production.

Recently, according to the improvement of living standards and heightened aesthetic demands, the concept of medical skin care has led to active skin care behaviors to maintain beautiful skin in addition to supporting roles in the treatment of diseases. In previous studies, the higher the degree of health promotion, the higher the awareness of skin health management, and the higher the skin knowledge, the higher the interest in healthy and beautiful skin. Skin health, health promotion behaviors, and appearance management increase as one's willpower increases, so awareness education on the concept is necessary (Jeun & Kim, 2008). Kim et al. (2020) suggests the purpose of skin health behavior is to prevent skin aging and to minimize skin diseases by better lifestyle, selection and use of cosmetics, and skin care habits. To maintain healthy skin, one has to thoroughly wash their face to minimize damages against fine dust and harmful oxygen.

There exist various factors that affect skin health. Physiological factors caused by abnormal sebum secretion, the endocrine system, the circulatory system, metabolic activity, and nutritional deficiency in skin cells. Nutritional factors caused by abnormal eating habits and various diseases. Internal medical factors caused by pregnancy and childbirth. External factor caused by polluted air, wind, temperature change, dry air, hot and humid air. Psychological factors due to stress. Behavioural factors such as lack of sleep, fatigue, diet, cosmetics ingredients, overuse of alkaline soap, lack of knowledge of cosmetics use. As such, skin health is determined by the complex interaction of various factors, and skin health can be improved according to individual efforts (Kim, 2006).

2.2. Prior research on data and social awareness

Types of big data include structured data, which is a vast amount of digitized data that is difficult to store, manage, and analyze as the internet has become popular, and unstructured data generated in the online environment (SNS, Facebook, YouTube videos, Instagram, etc.) Big data analysis includes text mining, topic modeling, opinion mining, social network analytics, and semantic network analytics (Choi, 2020). Big data is recognized as a new paradigm shift that is more than just a new technology or business model. In order to create economic value using big data and gain a competitive edge in the big data market, it is necessary to identify big data technology trends and gain the economic upper hand. Preoccupation is important (Choi, 2018). Big data is not just a collection of data, but can help derive meaningful and economical value (Jung & Chang, 2016), predict customer behavior in advance and prepare countermeasures to strengthen corporate competitiveness, and improve productivity in businesses (Park, 2020).

Studies using big data can be classified into trend analysis, trend prediction, and social awareness analysis. Looking at previous studies related to social awareness, Suh et al. (2019) on the free semester system, high school credit system, and process-centered evaluation, and it was found that the current social, educational field, and economic situation are closely related to each other with a high frequency of evaluation, curriculum, students, class, and research in a study on cognition over the past five years, in which general interest was focused. Jung & Kim (2022) analyzed the social perception of early childhood education policy and childcare policy for 4 years as a keyword for low birth rate, and stated that the low birth rate has a close relationship with between human, physical, environmental, and policy-related factors. In particular, it was confirmed that the low birth rate formed active intervention and

support from the state and the public as well as formed social support and consensus. Baek & Ju (2021) looked at the changes in social awareness of beauty devices, which are growing rapidly worldwide, on news and portal sites. Beauty devices were recognized in relation to face lifting and LED masks as they are most related to skin, and consumer awareness was influenced by the social atmosphere, reviews, and advertisements, and was able to identify issues such as overseas expansion, cosmetics, and medical fields.

As described above, studies on understanding social awareness using big data have been actively conducted recently. These studies can be useful in our study to predict trend changes and development directions that identify the needs in the skin health field.

3. Research Methodology

3.1. Data collection

The data used in this study are provided by Textom (2023), which uses blogs, news, cafes, Facebook, and Youtube from Naver, Daum, and Google. The search term is 'skin health' and the collection period is the last two years (May 3, 2021 – May 3, 2023). A total of 4,386 data points were collected: 687 blogs, 2,184 news articles, 690 cafes, 275 Facebook pages, and 550 YouTube videos.

3.2 Data processing and analysis

The collected data was subjected to data refinement through text mining. For the first refinement, morphemic analysis was performed, focusing on noun keywords. In addition, meaningless keywords with single syllables were deleted, and the meaning was confirmed to unify word spacing. In the secondary refinement, keywords with unknown meanings were deleted, synonyms and synonyms were unified as representative keywords, keywords were extracted, monosyllabic keywords were deleted, spaces were checked, and synonyms and synonyms were unified. Among the refined data, the top 50 keywords with high frequency were selected as the final network analysis data. Among them, 'skin', 'health', and 'skin health' appeared at the highest frequency but were deleted because they are commonly implied in all data. The main examples are shown in Table 1.

Table 1: Data Processing Standards

Division	Method	Example
Deletion	Search word	Skin, Care, Skin Health
Integrated	Similar concept	Surgery →Treatment, Cosmetology→Beauty
Absorption	Unity of spacing	Health Functional Food→Health functional food, Fine Dust→Fine dust

3.3. Analysis tools and data analysis

Textom (2023), a big data analysis program, was used to collect and refine the data. UCINET, a network analysis program, analyzed the relationship between keywords, and NetDraw visualized it. For the refined data, frequency analysis was performed to select the top 50 words, and network analysis was performed by constructing 50x50, 1-mode mattress data. First, the network analysis performed in this study looked at nodes, density, average degree distance,

average degree strength, number of components, diameter, and network concentration to identify the structural properties of the network related to skin health. Second, degree centrality, closeness centrality, betweenness centrality, and eigenvector centrality analysis were conducted to examine the centrality aspects of the network. Third, CONCOR analysis was conducted to identify the network structure of subgroups.

4. Results and Discussion

4.1. Keyword frequency analysis related to skin health

Keywords related to skin health were extracted through big data, and the top 50 keywords with the highest frequency were selected as the final analysis target through a refinement process (Table 2). As a result of frequency analysis, collagen (544 times) was the most common, followed by product (524 times), care (482 times), use (440 times), improvement (418 times), melanin (391 times), aging (372 times), cosmetics (359 times), ultraviolet rays (342 times), and vitamins (300 times). In addition, keywords related to environmental factors such as dryness (290), changing seasons (239), temperature (176), and fine dust (141), or keywords related to diet such as diet (192) and food (155) also ranked in the rankings. Additionally, words such as Galaxy Watch (197) and Technology (161) also appeared as words related to skin health.

From the above results, it can be seen that collagen is recognized as the most important factor in relation to skin health. Collagen is a kind of protein that accounts for 70 to 80% of the dermal layer of the skin and is a component that maintains skin elasticity and skin tissue structure. Aging can cause wrinkles and loss of elasticity due to the degradation of protein synthesis components. To compensate for this, functional cosmetics, supplements, and AI-integrated devices are being released (Cho & Chung, 2012). Jin et al. (2016), in a study on collagen intake and facial skin wrinkles, suggested that collagen intake tends to alleviate skin wrinkles, and when collagen in the blood increases, collagen synthesis in the skin dermis increases and elasticity is maintained, contributing to skin recovery.

Cosmetics are also recognized as a major means to maintain skin health. Cosmetics can be applied conveniently and periodically in daily life, and functional cosmetics such as whitening and wrinkle improvement are steadily used. Recently, however, complex functional cosmetics such as bio and nano, as well as high-functional cosmetics using natural materials and high-tech technologies, have also been rapidly increasing.

Table 2. Frequency analysis of keywords related to Skin Health

Rank	Keyword	N	Rank	Keyword	N
1	Collagen	544	26	Diet	192
2	Product	524	27	Therapy	189
3	Care	482	28	Broadcast	187
4	Use	440	29	Dermatitis	186
5	Improvement	418	30	Beauty	184
6	Maintain	391	31	Immunity	184
7	Aging	372	32	Temperature	176

8	Cosmetics	359	33	Prevention	175
9	UV-rays	342	34	Damage	171
10	Vitamin	300	35	Service	169
11	Dry	290	36	Worry	167
12	Effect	289	37	Prediction	166
13	Ingredient	261	38	Antioxidant	162
14	Elasticity	254	39	Technology	161
15	Launch	243	40	Moisturizing	157
16	Importance	242	41	Food	155
17	Atopy	241	42	Health functional food	155
18	Change of season	239	43	Raw material	153
19	Brand	228	44	Stimulation	145
20	Efficacy	226	45	Intake	144
21	Contain	225	46	Fine dust	141
22	Life Health	211	47	Symptom	140
23	Barrier	209	48	Promotion	139
24	Patient	207	49	Nutrients	139
25	Galaxy Watch	197	50	Person	136

4.2. Overall network analysis related to skin health

As a result of examining the properties of the network structure for skin health-related keywords, the node was 50, the density was 0.783, the average degree strength was 38.360, the average degree distance was 1.217, the component was 1, the diameter was 2, and the network centrality was 4.33% (Figure 1). This result means that one keyword is associated with an average of 1.21 other keywords, and all keywords are associated with a maximum of 2 keywords. Figure 1 shows the visualization of the 50 keywords selected for analysis.

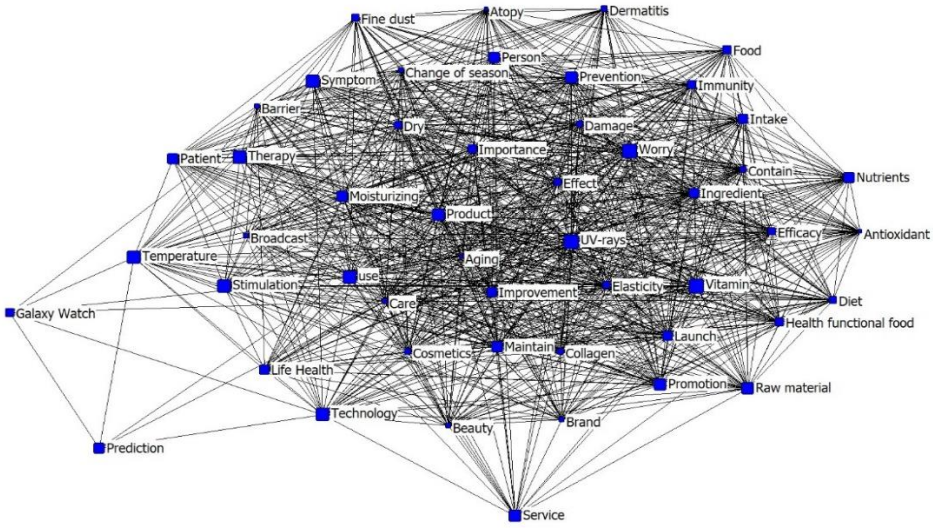

Figure 1. Network structure for Skin Health related keywords

4.3 Centrality analysis for skin health keywords

In order to find out the network properties of social perception of skin health, a centrality analysis was conducted, and the top 10 keywords were presented (Table 3, Table 4). First, as a result of degree centrality analysis, the keywords with the highest ranking were product (0.080) and usage (0.080), followed by collagen (0.076), improvement (0.070), and cosmetics (0.067). This establishes a connection and acts as a hub. In particular, words such as cosmetics and Galaxy Watch have a higher degree centrality than frequency ranking, indicating a relatively high degree strength. As a result of closeness centrality analysis, management (1.000) and use (1.000) ranked highest, and product (0.979), improvement (0.979), and ultraviolet rays (0.979) also appeared high in the rank. Words like this are located close to other keywords can easily influence others. In particular, management, ultraviolet rays, and influence have a higher closeness centrality than frequency and thus have an effect on closer closeness keywords.

Table 3. Degree centrality & Closeness centrality analysis of keywords related to Skin Health

Rank	**NrmDgree**		**Closeness**	
1	Product	0.080	Care	1.000
2	use	0.080	use	1.000
3	Collagen	0.076	Product	0.979
4	Improvement	0.070	Improvement	0.979
5	Cosmetics	0.067	UV-rays	0.979
6	Maintain	0.066	Effect	0.969
7	Care	0.061	Importance	0.959
8	Vitamin	0.054	Maintain	0.948
9	Galaxy Watch	0.053	Aging	0.948
10	Aging	0.052	Cosmetics	0.948

As a result of betweenness centrality analysis, management (2.726) and use (2.726) ranked highest, followed by technology (1.486), temperature (1.216), and symptom (0.991). These words play an intermediary role amongst other keywords. In particular, technology, temperature, etc. have higher rankings of betweenness centrality than frequency rankings, which means that these words have a better mediating role between keywords.

Finally, as a result of the eigenvector centrality analysis, the Galaxy Watch (0.300) ranked highest, followed by use (0.293), prediction (0.280), temperature (0.278), and product (0.249). These words are keywords that are most closely related to keywords with high centrality around them, which means that they have a high connection with relatively important keywords.

In particular, Galaxy Watch, prediction, temperature, and technology had higher eigenvector rankings than frequency rankings, indicating that the keywords are closely related.

Table 4. Betweenness centrality & Eigenvector centrality analysis of keywords related to Skin Health

Rank	nBetweenness		Eigenvector	
1	Care	2.726	Galaxy Watch	0.300
2	use	2.726	use	0.293
3	Technology	1.486	Prediction	0.280
4	Temperature	1.216	Temperature	0.278
5	Symptom	0.991	Product	0.249
6	Product	0.586	Collagen	0.222
7	Improvement	0.586	Cosmetics	0.212
8	UV-rays	0.586	Maintain	0.199
9	Importance	0.498	Improvement	0.186
10	Cosmetics	0.477	Technology	0.171

In a preceding study, Oh (2022) used big data to examine research trends in the field of skin care, and as a result, cosmetics keywords showed high connection centrality, closeness centrality, and betweenness centrality. Baek & Ju (2021) reported that in the analysis of social awareness of beauty devices betweenness centrality of cosmetic keywords was high. As a result of examining big data cosmetics trend analysis by Park (2020) all cosmetic keywords were found to be high in connection centrality, closeness centrality, and betweenness centrality, indicating that cosmetics are being recognized and studied very closely in the skin-related field. Park & Oh (2022) used big data to examine research trends in the field of anti-aging. In the centrality analysis, cosmetics and improvement appeared high in connection centrality and closeness centrality, and collagen and melanin appeared high in betweenness centrality, which is similar to our studies. In the results of connection centrality and eigenvector centrality, technology and Galaxy Watch appeared high, which showed that the health care field and skin health are closely related. It can be seen that there are various attempts to develop consumer-customized technologies or products that are grafted onto this (Kim, 2022).

4.4. CONCOR analysis related to skin health

Keywords with similarities in social perception of skin health were clustered, and CONCOR analysis was conducted to identify their characteristics (Table 5) and to visualized them in Figure 2. Cluster 1 includes keywords such as vitamin, raw material, promotion, product, and prevention, and is named skin nutrition cluster. Cluster 2 includes keywords such as ultraviolet rays, troubles, irritation, people, moisturizing, and elasticity, and is named skin irritation. Cluster 3 includes treatment, symptoms, patients, dermatitis, and fine dust, and is named skin disease. Cluster 4 includes keywords such as technology, use, temperature, service, and prediction, and is named BeautyTech.

In a previous study, Ku, et al. (2021) studied well-aging factors using big data. As a result of CONCOR analysis, the anti-aging cluster included cosmetics, improvement, wrinkles, and procedures, which was similar to the skin nutrition cluster in this study. Kim & Kim (2009) stated that vitamin C was effective in collagen synthesis, skin elasticity, and antioxidant in a study on vitamins and facial skin condition, and it was found that vitamin, intake, immunity,

and homeostasis were classified into the same cluster, indicating high relevance.

Table 5. CONCOR analysis of keywords related to skin health

Group	Keywords	N
Skin nutrition	Vitamin, Raw material, Promotion, Product, Prevention, Intake, Nutrient, Launch, Improvement, Maintain, Immunity, Life Health, Health functional food, Ingredient, Diet, Collagen, Cosmetics, Brand, Contain, Antioxidant, Aging	23
Skin stimulation	UV-rays, Worry, Stimulation, Person, Moisturizing, Elasticity, Importance, Food, Damage, Dry, Care, Barrier, Broadcast, Beauty	14
Skin disease	Therapy, Symptom, Patient, Dermatitis, Fine dust, Change of season, Atopy	7
Beauty tech	Technology, Use, Temperature, Service, Prediction, Galaxy Watch	6

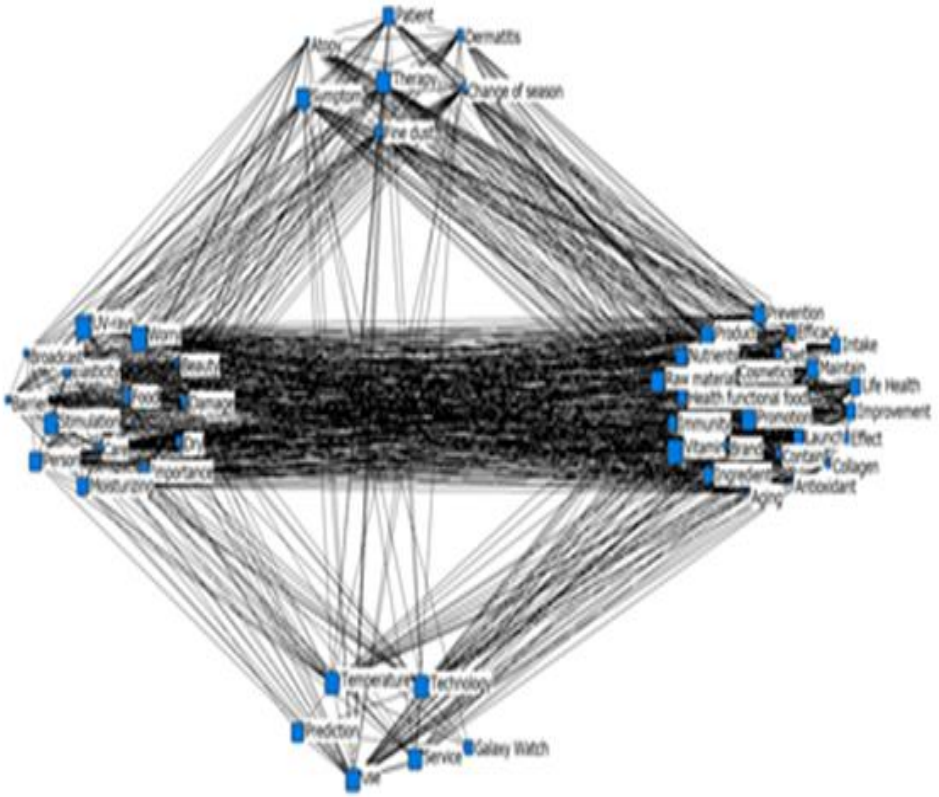

Figure 2. Visualization of CONCOR Analysis

5. CONCLUSION

In this study, we conducted a network analysis using a large amount of web data that circulates rapidly to understand social awareness of skin health. The results of the study are summarized and the conclusions drawn are as follows.

First, as a result of frequency analysis centering on keywords related to skin health in web data for the past two years, collagen appeared the most, followed by product, care, use, improvement, melanin, aging, cosmetics, ultraviolet rays, and vitamins in the respective order; additionally, other words such as dryness, change of season, and diet also appeared with high frequency. Through these results, it can be seen that collagen, a major component of the dermal layer of the skin, is a keyword for skin health, and it is confirmed that products or cosmetics to keep the components of the skin healthy are also recognized as important. In addition, it was confirmed that environmental stimulants such as ultraviolet rays, dryness, and changing seasons, as well as diet-related keywords such as vitamins and diet, were also recognized as important subjects. In particular, keywords such as Galaxy Watch and technology were ranked in the rankings, implying that devices and information incorporating digital technology are drawing new attention to skin health.

Second, it was possible to macroscopically examine the structural properties of the entire network for skin health using Netdraw, and it was found that each keyword was complexly connected due to the high density and average connection strength between keywords.

Third, as a result of conducting a centrality analysis on words such as skin health, product, use, collagen, improvement, cosmetics, and Galaxy Watch showed high connection centrality. These keywords act as hubs that interact strongly with other keywords. With the recent development of technology, it can be seen that various products and information are being derived to maintain and improve skin health, centering on cosmetics and Galaxy Watch. As a result of closeness centrality analysis, management, use, product, improvement, and ultraviolet rays ranked high. These keywords are located close to other keywords and are easy to influence others. UV rays have a close effect on skin conditions such as wrinkles and skin tone, and various products are available to prevent damage. As a result of betweenness centrality analysis, management, technology, temperature, and symptoms ranked high. These words are located in the center of other keywords and play a mediating role to expand to various topics. As a result of the eigenvector centrality analysis, keywords such as Galaxy Watch, prediction, temperature, and product were most closely related to keywords with high centrality around them. In the era of the 4th industrial revolution, new technologies and devices are expected to have a very important impact on skin health in the future.

Fourth, as a result of conducting a CONCOR analysis on skin health and clustering, it can be divided into skin nutrition, skin irritation, skin disease, and beauty tech. Therefore, for maintenance of skin health, education for improvement, product development, and marketing, one should establish a strategy by dividing the concept of consumers based on these four keywords.

This study is significant in that it identified social awareness of skin health and explored structural relationships between keywords using big data analysis. However, the range of data was extracted mainly from domestic social data, and the data collection period was the last

two years, so there were limitations in examining changes in perception. In the future, it will be possible to expand the scope and period of data collection and to conduct research that looks at the changes from the point of view of COVID-19.

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