

# A Study on the General Public's Perceptions of Dental Fear Using Unstructured Big Data

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**Background:** This study used text mining techniques to determine public perceptions of dental fear, extracted keywords related to dental fear, identified the connection between the keywords, and categorized and visualized perceptions related to dental fear.

**Methods:** Keywords in texts posted on Internet portal sites (NAVER and Google) between 1 January, 2000, and 31 December, 2022, were collected. The four stages of analysis were used to explore the keywords: frequency analysis, term frequency-inverse document frequency (TF-IDF), centrality analysis and co-occurrence analysis, and convergent correlations.

**Results:** In the top ten keywords based on frequency analysis, the most frequently used keyword was 'treatment,' followed by 'fear,' 'dental implant,' 'conscious sedation,' 'pain,' 'dental fear,' 'comfort,' 'taking medication,' 'experience,' and 'tooth.' In the TF-IDF analysis, the top three keywords were dental implant, conscious sedation, and dental fear. The co-occurrence analysis was used to explore keywords that appear together and showed that 'fear and treatment' and 'treatment and pain' appeared the most frequently.

**Conclusion:** Texts collected via unstructured big data were analyzed to identify general perceptions related to dental fear, and this study is valuable as a source data for understanding public perceptions of dental fear by grouping associated keywords. The results of this study will be helpful to understand dental fear and used as factors affecting oral health in the future.

**Key Words:** Big data, Conscious sedation, Data mining, Dental anxiety, Perception

## Introduction

### 1. Background

Dental phobia is used interchangeably with dental fear and is defined as avoidance of dental treatments owing to a feeling of loss of self-control during dental treatments regardless of whether treatments are simple or complex<sup>1)</sup>. A previous study showed that the prevalence of dental fear is 44.4% and 16.1% in children and adults, respectively<sup>2,3)</sup>. Another study demonstrated that approximately 5% to 10% had extreme dental fear<sup>4)</sup>.

People with high dental fear have lack of cooperation during dental treatment and are much more likely to avoid dental visiting by postponing or canceling their appointments<sup>5,6)</sup>. Missing regular dental care due to dental fear is

associated with poorer oral health<sup>7)</sup>. Managing dental care is required for oral health in the interest of patients. Moreover, dental care providers should strive to understand patients' perception of dental fear in terms of patient management.

Since dental fear is related to cognition, people with dental fear seek information about how to reduce dental fear before dental visiting and can have power of subjective control over dental fear<sup>8)</sup>. Therefore, investigating information sought by people with dental fear and analyzing the association between the information are expected to help investigating people's perception of dental fear. Previous studies reported that dental fear is associated with negative cognitive factors, such as past experiences, dental anesthesia, use of dental scaler, dental X-ray use, noise,

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pain, and cost<sup>9,10</sup>). Although these previous studies can be used to determine negative cognitive factors in patients with dental fear, there is a limitation in generalizing their findings to the public.

Text mining in big data analytics allows keyword extraction from various types of data, pattern recognition, and pattern analysis. Text mining, which categorizes and visualizes a relationship and connection between the extracted keywords, entails a quantitative approach to the analysis voluminous textual data<sup>11</sup>). However, little research, using unstructured data analysis technology, has been conducted in dentistry. In Korea, studies on dental hygienists' perception of work performance<sup>12,13</sup>) and an online survey study that reviews patients having dental visits were reported<sup>14</sup>).

## 2. Objectives

This study aims to extract keywords with dental fear, investigate the relationship and connection between the keywords, and categorize and visualize people's perception of dental fear. Future research will be conducted to establish the structures of perceptions related to dental fear based on the outcomes from numerous unstructured data that were quantitatively analyzed.

## Materials and Methods

### 1. Ethics statement

Since data used in this study did not contain personally identifiable information, this study was granted exemption from review by the Institutional Review Board of Shinhan University (IRB No.: SHIRB-202309-HR-212-03).

### 2. Study design

This study analyzed people's perception of dental fear in Korea using the text mining technique in big data analytics that involves objectively analyzing further perception of dental fear in Korea.

### 3. Sample size

In this study, TEXTOM 6.0 was used to collect data from NAVER (www.naver.com; blogs, news, web documents, NAVER IN, and academic information), Google (www.google.com; web documents, news, and Facebook),

and Daum (web documents, blogs, news, and cafes), as the spatial range, to identify public perception of dental fear. The temporal range was set from 1 January, 2000, to 31 December, 2022, for 13 years. This range was set based on the increasing pattern that studies on dental fear survey had increased in Korea and other countries since 2000<sup>15</sup>).

### 4. Data collection and preprocessing process

Fig. 1 illustrates the three stages of the data analysis process. At the first stage, Textom 6.0 was used to collect data. Textom, a program that can efficiently analyze unstructured big data, utilizes text mining techniques to collect significant keywords from numerous unstructured data. It is a useful collecting and analyzing tool to perform centrality analysis through frequency and semantic network<sup>16</sup>). It identifies core keywords from various types of texts, selects essential keywords, and develops a matrix to investigate the frequency of co-occurrence of keywords. Textom can delete data unrelated to the study subject from the collected data and performed cleaning process to combine words with spaces and without spaces if they have the same meaning<sup>17</sup>). The core keyword was set as 'dental fear' to collect text. Large amounts of relevant data were extracted from web pages (NAVER and Google) using a mechanical method, and crawling was used to extract a total of 14,087 keywords. To analyze the collected data, text preprocessing was performed to segment morpheme and remove stopwords<sup>18</sup>). To minimize the impacts of dupli-

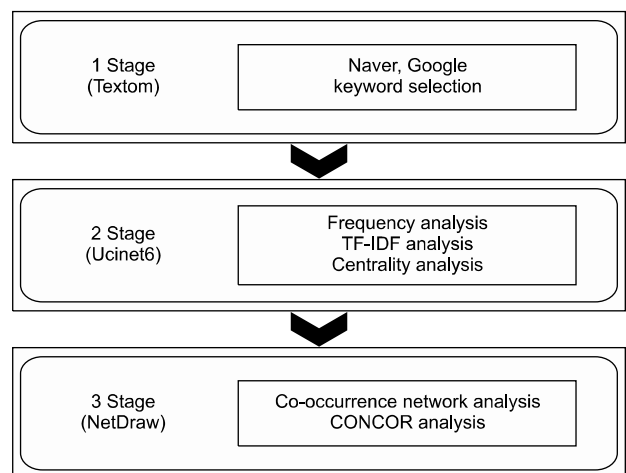


Fig. 1. Analysis process. TF-IDF: term frequency-inverse document frequency, CONCOR: CONvergence of iteration CORrealion.

cates, keywords were removed by performing URL deduplication. Mecab, a morpheme module for efficient analysis of Korean language, was used to extract consistent outcomes.

### 5. Data analysis

UCINET 6 was used for frequency analysis and term frequency-inverse document frequency (TF-IDF) analysis. TF-IDF measures how important a keyword appears in a document, and the higher the frequency, the more important that word is<sup>19)</sup>. Degree centrality and eigenvector centrality were used for centrality analysis. Degree centrality measures the number of connections between keywords, and an influence between the connected nodes increases when the value is larger<sup>20)</sup>. Eigenvector centrality measures the importance of a node connection to reflect it to weighted node connection, which expands the concept of degree centrality<sup>20)</sup>. At the third stage, co-occurrence analysis was conducted using the UCINET 6 Netdraw tool to demonstrate the connectivity between the top 30 keywords collected by Textom. In co-occurrence analysis, study subjects expressed by two words are considered related each other if the two words are used in the same document<sup>21)</sup>. CONCOR (CONvergence of iteration CORrealtion) analysis considers the correlation between the keywords which are in a similar structural location among the total network structure and is a clustering analysis that classifies keywords with high connection into one cluster<sup>22)</sup>.

## Results

### 1. Frequency of the top keywords and TF-IDF analysis

Among the keywords collected for analysis, the top 30 core keywords used for analysis are listed in the Table 1 with their frequency and TF-analysis results. In the top 10 keywords, the most frequently used keyword was ‘treatment,’ followed by ‘fear,’ ‘dental implant,’ ‘conscious sedation,’ ‘pain,’ ‘dental fear,’ ‘comfort,’ ‘taking medication,’ ‘experience,’ and ‘teeth.’ In the top 10 keywords based on TF-IDF analysis, ‘dental implant’ had the highest value, followed by ‘conscious sedation,’ ‘dental fear,’ ‘patient,’ ‘treatment,’ ‘pain,’ ‘taking medication,’ ‘teeth,’ ‘endodontic treatment,’ and ‘comfort.’ The keywords took third (dental

implant), fourth (conscious sedation), and sixth (dental fear) place in the frequency analysis were in the top three of the TF-IDF analysis, demonstrating that there are differences in the frequency and importance between the keywords used in the texts. Keywords ranked by TF-IDF analysis differed from the keywords ranked by frequency analysis, and this shows that the public was more likely to perceive the word, dental fear, negatively.

### 2. Centrality analysis

Table 2 shows the results of centrality analysis that was performed to identify connections between the keywords for dental fear in terms of characteristics between the networks.

Table 1. Keyword Frequency and TF-IDF Analysis on Dental Fear

Keyword	Frequency	Rank	TF-IDF	Rank
Treatment	6,288	1	2,001.3	5
Fear	5,779	2	1,484.0	14
Dental implant	4,779	3	4,400.6	1
Conscious Sedation	2,749	4	2,477.8	2
Pain	2,016	5	1,984.4	6
Dental fear	1,504	6	2,252.8	3
Comfort	1,409	7	1,754.7	10
Taking medication	1,275	8	1,973.6	7
Experience	1,166	9	1,701.2	11
Teeth	1,045	10	1,843.7	8
Patient	1,004	11	2,006.9	4
Reservation	991	12	1,587.2	12
Expectation	965	13	1,559.4	13
Endodontic treatment	721	14	1,780.5	9
Dentist	712	15	1,457.6	15
Anxiety	644	16	1,338.2	19
Children	583	17	1,409.3	18
Dental caries	582	18	1,420.5	17
Recommendation	577	19	1,440.6	16
Anesthesia	486	20	1,230.7	20
Cost	405	21	1,092.7	22
Wisdom tooth	397	22	1,102.7	21
Surgery	392	23	1,060.1	23
Overcome	368	24	1,058.0	24
Adult	310	25	869.4	25
Relieve	241	26	742.5	27
Advantages	233	27	779.7	26
Noise	211	28	673.0	28
Worry	196	29	654.7	29
Burden	195	30	652.5	30

TF-IDF: term frequency-inverse document frequency.

**Table 2.** Comparison of Keywords Frequency and Centrality on Dental Fear

Keywords	Centrality degree		Eigenvector degree	
	Index	Rank	Index	Rank
Treatment	822.288	1	0.482	1
Fear	659.729	3	0.413	3
Dental implant	769.339	2	0.465	2
Conscious Sedation	459.542	4	0.321	4
Pain	349.593	5	0.247	5
Dental fear	146.949	11	0.094	13
Comfort	273.373	6	0.2	6
Taking medication	239.271	8	0.182	7
Experience	242	7	0.181	8
Teeth	139.661	12	0.096	11
Patient	124.576	13	0.096	12
Reservation	214.678	9	0.161	9
Expectation	212.034	10	0.159	10
Endodontic treatment	86.237	17	0.058	18
Dentist	83.966	18	0.059	17
Anxiety	90.525	15	0.062	15
Children	54.136	22	0.035	22
Dental caries	87.898	16	0.06	16
Recommendation	96.254	14	0.071	14
Anesthesia	62.881	20	0.044	20
Cost	74.254	19	0.055	19
Wisdom tooth	49.39	23	0.034	23
Surgery	54.915	21	0.038	21
Overcome	39.644	25	0.025	25
Adult	40.305	24	0.025	26
Relieve	34.237	27	0.024	27
Advantages	36.881	26	0.028	24
Noise	31.644	28	0.022	28
Worry	23.847	30	0.017	30
Burden	27.814	29	0.02	29

For centrality, we used degree centrality and eigenvector centrality. Degree centrality that can measure the influences of activities of keywords was conducted, showing that ‘treatment’ has the highest number of connection, followed by ‘dental implant,’ ‘conscious sedation,’ and ‘pain.’ Top five keywords in the eigenvector centrality that weighted the correlation between the keywords were same as those in the degree centrality.

### 3. Co-occurrence analysis

Keywords related to dental fear have relativity. The frequency of co-occurrence of the keywords was investigated, showing that the number of word types appear together was 6,000, and the frequency of co-occurrence was 76,069. The keywords ‘fear’ and ‘treatment’ appeared together the most frequently, with 1,322 times, followed by the keywords ‘conscious’ and ‘dental implant,’ with 1,268 times and the keywords ‘treatment’ and ‘pain,’ with 1,088 (Table 3).

### 4. CONCOR analysis

CONCOR analysis was performed to group the keywords as listed in Table 4 and shown in Fig. 2. The first group was related to common perceptions related to dental fear. Images related to the dentist are demonstrated via keywords, such as ‘patient,’ ‘teeth,’ and ‘dentists.’ Also, this group shows a combination of negative words (dental fear, endodontic treatment, worry, and anesthesia) and positive words (comfort). Accordingly, we can assume that various images for dental fear are present in the first group. The

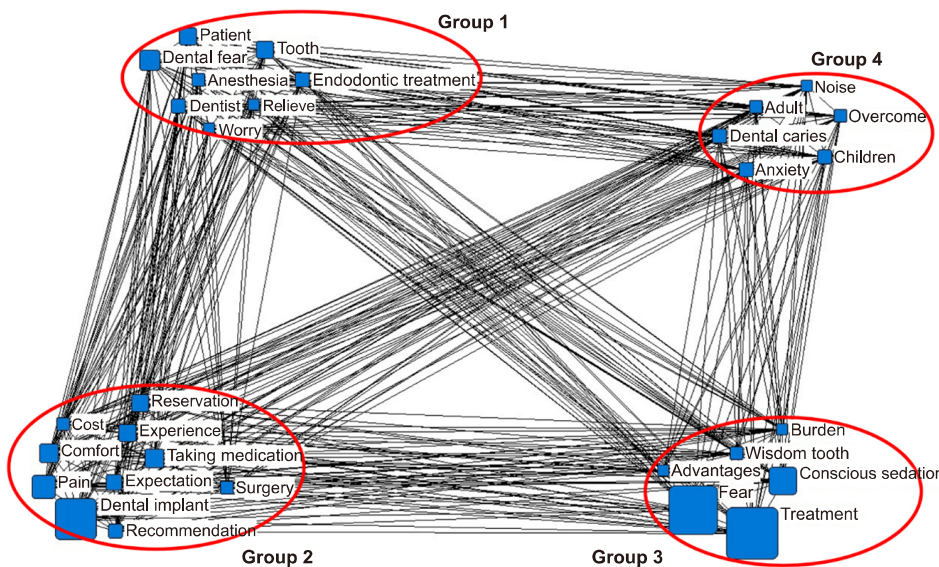
**Table 3.** Co-Occurrence Network Analysis on Dental Fear

	Frequency	Percentage (%)
Fear → Treatment	1,322	1.74
Conscious Sedation →Dental implant	1,268	1.67
Treatment → Pain	1,088	1.43
Comfort → Dental implant	1,025	1.35
Dental implant → Experience	968	1.27
Experience → Comfort	956	1.26
Taking medication → Conscious Sedation	956	1.26
Pain → Taking medication	956	1.26
Dental implant → Expectation	954	1.25
Expectation → Reservation	953	1.25

**Table 4.** Dental Fear CONCOR Analysis

Group	Characteristic	Keyword	No
Group 1	Common perceptions related to dental fear	Dental fear, Patient, Tooth, Dentist, Endodontic treatment, Worry, Anesthesia, Relieve	8
Group 2	Factors to consider to overcome dental fear	Dental implant, Experience, Expectation, Recommendation, Taking medication, Comfort, Reservation, Pain, Surgery, Cost	10
Group 3	Perceptions related to wisdom tooth extraction	Wisdom tooth, Fear, Burden, Conscious Sedation, Advantages, Treatment	6
Group 4	Perceptions related to dental caries	Dental caries, Adult, Overcome, Anxiety, Children, Noise	6

No: number of words per group, CONCOR: CONvergence of iteration CORrealtion.



**Fig. 2.** Visualization of CONCOR analysis. CONCOR: CONvergence of iteration CORrealtion.

second group was associated with the following considerations that people need to individually overcome dental fear: ‘experience,’ ‘expectation,’ ‘recommendation,’ ‘taking medication,’ ‘comfort,’ ‘reservation,’ ‘pain,’ ‘surgery,’ ‘cost,’ and ‘dental fear.’ The third group includes perceptions related to wisdom tooth extraction as a detailed factor for dental factor. The high correlations between ‘wisdom tooth,’ ‘fear,’ ‘burden,’ ‘conscious sedation,’ and advantages.’ The last group consists of perceptions related to dental caries, as a detailed factor for dental fear. Keywords, such as ‘dental caries,’ ‘adult,’ ‘children,’ ‘anxiety,’ ‘noise,’ and ‘overcome,’ were highly correlated. According to the keywords of third and fourth groups, we can speculate that the public specifies and perceives dental fear especially through wisdom teeth extraction and cavity treatment.

## Discussion

### 1. Key results and comparison with previous studies

This study analyzed unstructured big data using text mining techniques to identify public perceptions of dental fear. In this study, the most frequently used keywords related to dental fear were treatment, followed by fear, dental implant, conscious sedation, and pain. In TF-IDF analysis, the top three keywords were dental implant, conscious sedation, and dental fear (Table 1). This part elucidates that dental implant and conscious sedation are the most influential keywords for public perceptions related to dental fear. In co-occurrence analysis, ‘conscious sedation’ and ‘dental implant,’ taking second place, were repeated 1,268 times. This is elucidated by the fact that in the field of dental care, conscious sedation is actively recommended for those who

have dental fear or need to control fears of having dental implant. From the dental care users' perspective, people who have dental fear or fears of having dental implant surgery are more likely to be frequently exposed to information about conscious sedation while searching for relevant information. This can be the factor influencing decision process for dental treatment.

Conscious sedation, such as inhalation sedation, oral sedation, and IV sedation, helps the patients to be in a trance-like state and can change patients' responses to dental treatments to positive responses by reducing pain or emotional damage during dental care<sup>23)</sup>. Based on the results of CONCOR analysis in this study, conscious sedation was classified into the group 3 with dental fear, burden, advantages, and wisdom tooth. This shows that conscious sedation is recognized as a benefit that reduces burden to surgical treatments. Patients have dental fear when they are having oral-surgical procedures, such as removal of wisdom tooth. Using conscious sedation for this situation will help reducing the patients' anxiety<sup>24,25)</sup>. A study by Kim et al.<sup>26)</sup> reported that pain was more reduced in the implant group with conscious sedation than the group without conscious sedation. Pain can be normally controlled during dental treatment or implant via local anesthesia, but fear of treatment is a psychological health issue<sup>27)</sup>. Therefore, using conscious sedation to ease nervous irritability is efficient to reduce fear<sup>28)</sup>. Accordingly, dental care providers should consider actively informing the public of accurate information about conscious sedation and recommending conscious sedation for providing comfort care for patients with dental fear, if needed.

In co-occurrence analysis, 'fear' and 'treatment,' taking first place, were repeated 1,322 times, and 'treatment' and 'pain,' taking third place, were repeated 1,088. Also, in the CONCOR analysis, dentist, dental fear, patient, and teeth were classified into group 1. Based on this result, we can interpret this result that public recognizes dental treatment as pain and pain as fear. Although the importance of visiting the dentist on a regular basis for oral health care is being emphasized, people recognize the dentist as a scary place and visit the dentist only when they have pain in most cases<sup>29)</sup>. Patients with advanced dental diseases due to missing regular dental check-up owing to dental fear need

treatment requiring anesthesia in most cases and are more likely to have pain on the course of treatment. Thus, this course of dental care is easily recognized as pain. A study by Shin et al.<sup>30)</sup> reported that the level of dental fear and worry is same as the level of pain and fear when people get a shot of anesthesia. Dentists should make an effort to ease dental patients' dental fear by actively considering the methods controlling pain, such as using local anesthesia on insertion site so that patients will not feel pain, injecting anesthetic fluids that are stored similar with the body temperature, injecting anesthetics slowly and constantly, and injecting anesthetics using painless anesthesia technique<sup>31,32)</sup>.

In this study, dental caries and anxiety are in the same classification (group 4). In previous studies investigating children's perceptions of oral health<sup>33)</sup>, dental fear was reported as an influencing factors for incidence of pain and caries. Moreover, a study conducted in adults demonstrated that the number of decayed teeth, missing teeth, and decayed-missing-filled-teeth (DMFT) was much higher when the level of dental fear was higher<sup>34)</sup>. Self-management of dental fear will help improve oral health.

Previous studies on dental fear<sup>35-37)</sup> reported the subjects' experiences with dental care or correlations between sociodemographic characteristics and dental fear induction by conducting survey questionnaire. However, the present study analyzed texts collected via unstructured data, used the results to identify general perceptions related to dental fear, and grouped keywords that have correlations. In this regard, the results of this study are valuable as evidence to understand public perceptions of dental fear.

## 2. Limitations and suggestions for further studies

In this study, since data were collected only from social portal sites, such as NAVER and Google, data should be collected from more various sources in future research. Moreover, since the time range was set from 2,000 when selecting data, and data during the overall period were analyzed, we were not able to change in perceptions according to time change. Therefore, future research should be conducted by dividing the study period to analyze keywords of texts for dental fear by periods and to review changes in perceptions.

## Notes

### Conflict of interest

No potential conflict of interest relevant to this article was reported.

### Ethical approval

The study was approved by the Institutional Review Board of Shinhan University (IRB No.: SHIRB-202309-HR-212-03).

### Author contributions

Conceptualization: Bo-Young Park and Han-A Cho. Data acquisition: Han-A Cho. Formal analysis: Han-A Cho. Supervision: Han-A Cho. Writing-original draft: Bo-Young Park and Han-A Cho. Writing-review & editing: Bo-Young Park and Han-A Cho.

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### Data availability

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

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