



# Analysis of the annual changes in dental institutions that claimed dental sedatives in Korea and the types of sedatives using health care big data

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**Background:** Dentists make various efforts to reduce patients' anxiety and fear associated with dental treatment. Dental sedation is an advanced method that dentists can perform to reduce patients' anxiety and fear and provide effective dental treatment. However, dental sedation is different from general dental treatment and requires separate learning, and if done incorrectly, can lead to serious complications. Therefore, sedation is performed by a limited number of dentists who have received specific training. This study aimed to investigate the proportion of dentists who practice sedation and the main sedatives they use in the context of the Republic of Korea.

**Methods:** We used the customized health information data provided by the Korean National Health Insurance. We investigated the number of dental hospitals or clinics that claimed insurance for eight main sedatives commonly used in dental sedation from January, 2007 to September, 2019 at the Health Insurance Review and Assessment Service. We also identified the changes in the number of dental medical institutions by region and year and analyzed the number and proportion of dental medical institutions prescribing each sedative.

**Results:** In 2007, 302 dental hospitals prescribed sedatives, and the number increased to 613 in 2019. In 2007, approximately 2.18% of the total 13,796 dental institutions prescribed sedatives, increasing to 3.31% in 2019. In 2007, 168 institutions (55.6%) prescribed N<sub>2</sub>O alone, and in 2019, 510 institutions (83.1%) made claims for it. In 2007, 76 (25.1%) hospitals made claims for chloral hydrate, but the number gradually decreased, with only 29 hospitals (4.7%) prescribing it in 2019. Hospitals that prescribed a combination of N<sub>2</sub>O, chloral hydrate, and hydroxyzine increased from 27 (8.9%) in 2007 to 51 (9%) in 2017 but decreased to 38 (6.1%) in 2019. The use of a combination of N<sub>2</sub>O and midazolam increased from 20 hospitals (6.6%) in 2007 to 51 hospitals (8.3%) in 2019.

**Conclusion:** While there is a critical limitation to the investigation of dental hospitals performing sedation using insurance claims data, namely exclusion of dental clinics providing non-insured treatments, we found that in 2019, approximately 3.31% of the dental clinics were practicing sedation and that N<sub>2</sub>O was the most commonly prescribed sedative.

**Keywords:** Big Data; Clinics; Dentistry; Healthcare Insurance; Nitrous Oxide; Sedation.



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## INTRODUCTION

Dental fear and anxiety (DFA) negatively impact

various aspects of patients' lives [1]. Many patients avoid visiting the dentist due to DFA, ultimately leading to a decrease in their quality of life [2,3]. Dentists make efforts to reduce patient anxiety through various methods,

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and sedation is one of those approaches [4].

However, in the Republic of Korea (hereafter, South Korea), dental sedation is not a medical procedure that all dentists can perform. The risk of death or serious complications associated with dental sedation makes it difficult for any dentist to perform the procedure without proper training [5]. To effectively perform dental sedation for patients with severe dental phobia or anxiety, dentists must receive adequate education. However, dental schools in South Korea do not provide sufficient training, including practical experience, on dental sedation. Instead, they only briefly introduce dental sedation as a regular course subject through a few hours of lectures [6].

In South Korea, there are no specific legal regulations for dentists to perform sedation. However, obtaining adequate education can be challenging. Currently, in South Korea, dental sedation is typically taught during a 3-year pediatric dentistry residency program or an oral and maxillofacial surgery residency program [7]. If a dentist does not go through a residency program, he/she can receive training through an 18-h or 60-h sedation workshop conducted by the Korean Dental Society of Anesthesiology or acquire sedation skills through various private educational courses [8].

In South Korea, sedation was first introduced by dentists who pioneered dental treatments for pediatric patients who were difficult to cooperate with, using oral or inhalation sedation methods [9,10]. Intravenous sedation was also used as a behavior modification method for treating intellectually disabled individuals with conditions, such as mental retardation or autism [11]. Subsequently, intravenous sedation was used for aggressive dental treatments in patients with severe anxiety [12]. It has been found that the demand for dental sedation is also increasing among adults requiring dental treatments [8].

According to data provided by the Korean Statistical Information Service (<http://kosis.kr>), South Korea implements a healthcare insurance system for the entire population. The Korean Healthcare Insurance Review &

Assessment Service (HIRA) provides deidentified insurance claim big data for research purposes, which has recently led to an increase in related studies [13].

This study was a follow-up to a published paper that used big data to investigate the current state of dental sedation [14]. The focus of this research was on the number of hospitals performing sedation and the continuation of the analysis. In this study, we aimed to report on the number of medical institutions implementing dental sedation in South Korea, the development of dental sedation, and the sedatives primarily used.

## METHODS

### 1. Study design and population

This study was a follow-up to a previous study [14]. Institutional Review Board approval was obtained from Seoul National University School of Dentistry (IRB No. S-020200006). The study was conducted after obtaining approval for using customized health information data from the Healthcare Bigdata Hub (<https://opendata.hira.or.kr/>), provided by the Korean Healthcare Insurance Review & Assessment Service (HIRA) (approval number: M20191014119). The research used data from the Korean National Healthcare Insurance Service payment dataset, covering the period from January, 2007 to September, 2019.

First, we investigated the insurance claims data for all patients who were prescribed any of the eight sedatives generally used in dental sedation (chloral hydrate, hydroxyzine, propofol, sevoflurane, midazolam, triazolam, nitrous oxide [N<sub>2</sub>O], and dexmedetomidine), as per the dental service form codes (FOM\_TP\_CD = '041' or FOM\_TP\_CD = '051') from the Healthcare Bigdata Hub. The total number of prescriptions was summed up for each unique dental institution ID (YID) in the dataset. We then determined the total number of dental institutions that prescribed sedatives and analyzed the data by year, region, and the types of sedatives prescribed.

## 2. Number of dental clinics and dental hospitals that claimed sedatives

We examined the data provided by HIRA from January, 2007 to September, 2019, which included claims for the eight sedative drugs. In South Korea, there were very few claims for triazolam, and dexmedetomidine was not covered by insurance, so there was not a single claim for it.

On running a query using the unique identification numbers (YID) of the dental institutions that claimed sedatives, a total of 1,334 institutions were found to have made claims for sedatives. The number of dental institutions that made claims for sedatives was calculated annually from 2007. Institutions that made claims for the first time in a certain year were considered to have started sedation practices in that year. Institutions with no claim data in the following years were considered to have stopped performing sedation.

The number of dental institutions was calculated by administrative regions and divided by year to determine the number of claiming institutions in each region. Additionally, the annual number of prescriptions for each dental institution was calculated, and the institutions were divided into six levels based on the number of sedation cases as follows: less than 10 cases/year, 10 to less than 50 cases, 50 to less than 100 cases, 100 to less than 500 cases, 500 to less than 1,000 cases, and over 1,000 cases per year. The growth trends in the number of institutions per level were analyzed by year.

## 3. Proportion of dental institutions prescribing sedation among all dental institutions

Using the numbers of dental hospitals, dental clinics, and general hospitals with dental departments provided by the Korean National Information Portal (<https://kosis.kr/>), we calculated the proportion of institutions that prescribed sedation. The proportions were calculated by year and administrative regions to examine the increase in dental institutions prescribing sedation. However, there was a limitation in that we could not

determine the number of dental institutions that did not claim insurance for sedation.

## 4. Types of dental sedation drugs

Lastly, we identified the types of sedation drugs for which the claims were made by each dental institution. We examined the composition ratio of dental institutions prescribing different types of dental sedation drugs by year and investigated the changes in the types of sedation drugs by administrative region.

## RESULTS

### 1. Number of dental hospitals or clinics that claimed dental sedation drugs

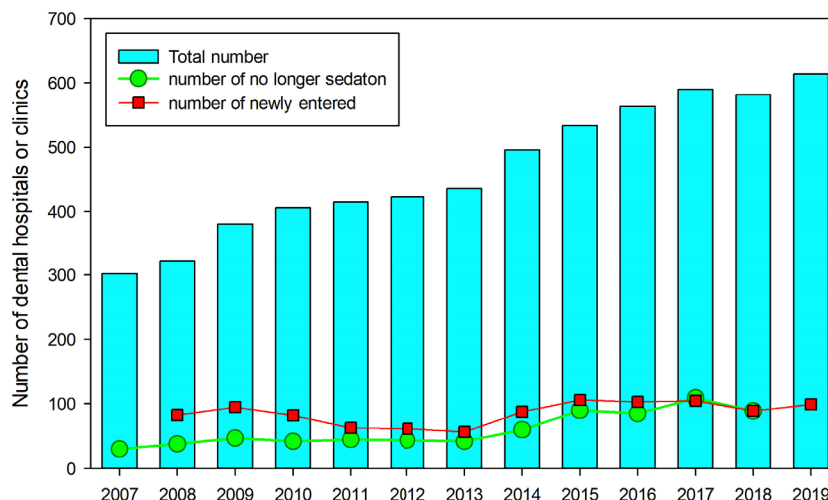
From January, 2007 to September, 2019, the total number of dental sedation claims was 1,649,688, and 1,334 dental hospitals or clinics made the claims. On investigating the number of cases and hospitals making claims for the most frequently used drugs, we found that in 86% of the total sedation cases, claims were made for N<sub>2</sub>O alone, followed by combination of N<sub>2</sub>O, chloral hydrate, and hydroxyzine (2.96%) and midazolam (2.52%). However, when looking at the number of hospitals making claims, 66.9% made claims for N<sub>2</sub>O alone, 34.2% for hydroxyzine alone, 17.8% for midazolam, and 16.0% for chloral hydrate. Further, compared to 10% of the total number of institutions that made claims for all sedative drugs, 7.64% of the hospitals made claims for the combined use of N<sub>2</sub>O, chloral hydrate, and hydroxyzine (Table 1).

On analyzing the number of dental hospitals or clinics that made claims for dental sedation drugs by year, it was found that 302 hospitals prescribed sedatives in 2007, and an average of 79 (57–106) hospitals began prescribing sedation drugs each year. In 2017, an average of 55 (30–109) hospitals stopped prescribing sedatives (Fig. 1).

To understand the scale of dental institutions that made claims for dental sedatives, the number of insurance claims per year for each dental institution was calculated,

**Table 1.** Number of dental hospitals or clinics claiming dental sedation drugs and the proportion of each sedative drug

Type of sedatives	claimed cases (%)	claiming hospitals or clinics (%)
Nitrous oxide	1432102 (86.81)	892 (66.86)
Chloral hydrate	10034 (0.6)	214 (16.04)
Nitrous oxide + Chloral hydrate	27930 (1.69)	99 (7.42)
Hydroxyzine	21789 (1.32)	456 (34.18)
Nitrous oxide + Hydroxyzine	15970 (0.96)	129 (9.67)
Chloral hydrate + Hydroxyzine	8993 (0.54)	117 (8.77)
Nitrous oxide + Chloral hydrate + Hydroxyzine	48838 (2.96)	102 (7.64)
Midazolam	41662 (2.52)	238 (17.84)
Nitrous oxide + Midazolam	17246 (1.04)	95 (7.12)
Midazolam + Chloral hydrate	349 (0.02)	38 (2.84)
Nitrous oxide + Midazolam + Chloral hydrate	5118 (0.31)	38 (2.84)
Midazolam + Hydroxyzine	94 (0)	22 (1.64)
Nitrous oxide + Midazolam + Hydroxyzine	202 (0.01)	24 (1.79)
Midazolam + Hydroxyzine + Chloral hydrate	4615 (0.27)	40 (2.99)
Nitrous oxide + Midazolam + Chloral hydrate + Hydroxyzine	8723 (0.52)	42 (3.14)
Propofol	4882 (0.29)	61 (4.57)
Propofol + Midazolam	187 (0.01)	34 (2.54)
Sevoflurane	739 (0.04)	27 (2.02)
Sevoflurane + Midazolam	73 (0)	7 (0.52)
Propofol + Sevoflurane	142 (0)	15 (1.12)
total	1649688 (100)	1334 (100)



**Fig. 1.** Graph of number of hospitals or clinics that made dental sedation drugs claims, stratified by year. The number of hospitals that began prescribing sedation drugs each year is shown in red, and hospitals that no longer prescribe sedation drugs are shown in light green.

and hospitals with high and low numbers of claims were divided into six categories: less than 10 cases per year, 10 or more cases but less than 50 cases, 50 or more cases but less than 100 cases, 100 or more cases but less than 500 cases, 500 or more cases but less than 1,000 cases, and 1,000 or more cases per year. In 2007, there were 40 hospitals (13.1%) that made claims for 500 or more

cases per year, but in 2015, this number had increased to 287 hospitals, accounting for 53.6% of the total 534 hospitals. In 2014, only four hospitals made claims for more than 2,000 cases per year, but in 2018, this number increased to 111, and as of September, 2019, a total of 108 hospitals had made claims for more than 2,000 cases (Fig. 2).

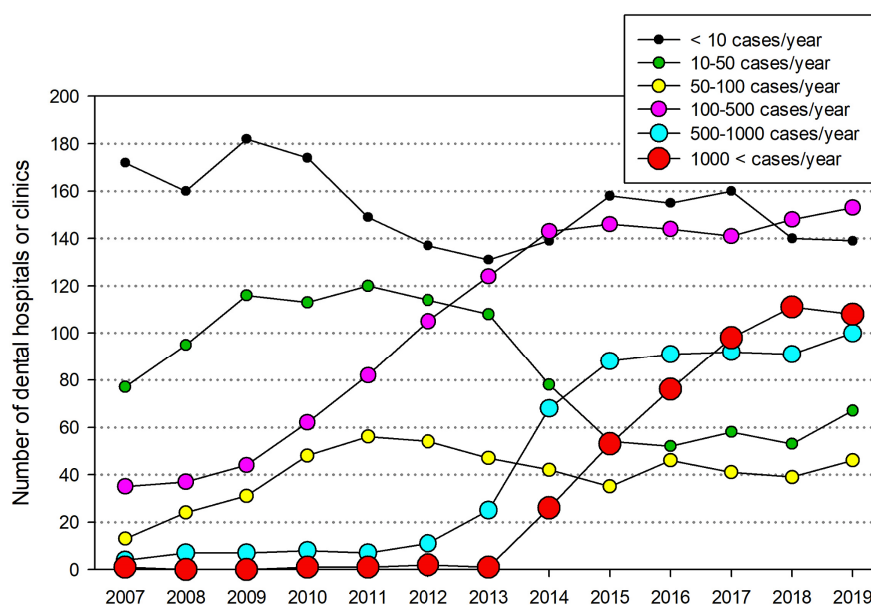


Fig. 2. Scale of dental institutions that claimed dental sedatives divided into six levels according to the annual insurance claim volume of each dental institution

Table 2. Yearly number of total dental healthcare institutions, number of hospitals claiming reimbursement for dental sedatives, and their respective ratios

Year	Tertiary general hospital	General hospital	Dental hospital	Dental clinic	Total	Sedatives claiming hospitals or clinics	ratio %
2007	43	261	153	13339	13796	302	2.18
2008	43	269	168	13750	14230	323	2.26
2009	44	269	183	14242	14738	380	2.57
2010	44	274	191	14681	15190	406	2.67
2011	44	275	199	15058	15576	415	2.66
2012	44	278	201	15365	15888	423	2.66
2013	43	281	203	15727	16254	436	2.68
2014	43	287	205	16172	16707	496	2.96
2015	43	294	213	16609	17159	534	3.11
2016	43	298	223	17023	17587	564	3.2
2017	43	301	231	17376	17951	590	3.28
2018	42	311	237	17668	18258	582	3.18
2019	42	313	239	17923	18517	614	3.31

## 2. The proportion of hospitals among all dental institutions that made claims for dental sedatives

According to data from the Korean National Information Portal (<https://kosis.kr/>), in 2007, there were 13,339 dental clinics, 153 dental hospitals, 43 tertiary hospitals with dental departments, and 261 general hospitals with dental departments. Among them, only 302 hospitals (2.18%) were billing for dental sedation medications under insurance coverage. However, the

number of hospitals billing for dental sedation has been increasing each year; in 2019, the total number of dental clinics and hospitals was 18,517, with 614 hospitals (3.31%) billing for dental sedation medications under insurance coverage (Table 2). It should be noted that these data are based solely on claims data submitted to the Health Insurance Review and Assessment Service; hence, the number of dental clinics and hospitals that prescribe dental sedation medications under non-insurance formats is not known. Nevertheless, it is clear that the number

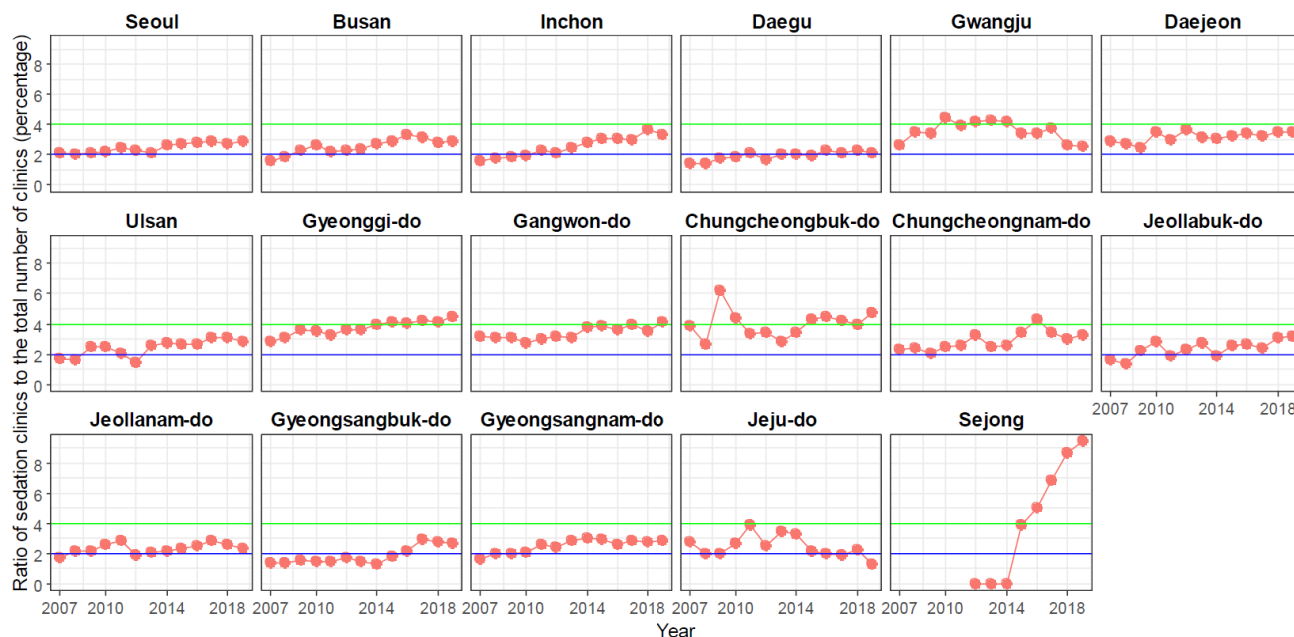


Fig. 3. Ratios of hospitals that claimed for dental sedatives to the total number of dental hospitals in each administrative district of South Korea over the years. The blue line represents the 2% mark, and the green line represents the 4% mark.

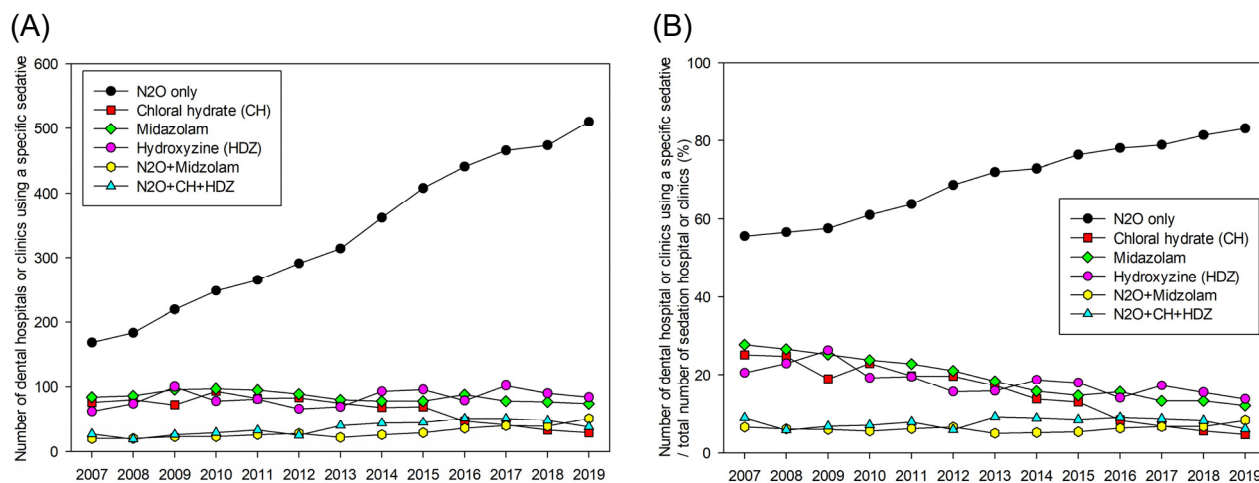


Fig. 4. Graphs of the numbers of hospitals making insurance claims for each type of dental sedatives. The number of dental hospitals using each type of sedative (A) and the proportion of each sedative relative to the total number of hospitals making claims for dental sedative drugs (B) are also shown by year. CH, chloral hydrate; HDZ, hydroxyzine; N<sub>2</sub>O, nitrous oxide.

of hospitals administering dental sedation is not large in South Korea, although the proportion is increasing over time.

Since there may be regional differences in the development of dental anesthesia in South Korea's administrative regions, we investigated the proportion of hospitals implementing dental sedation by region. Overall, the proportion ranged from 2–4%, with a sharp

increase seen in the newly developed city of Sejong (Fig. 3).

### 3. Analysis of the number of hospitals that made claims by type of sedatives

Table 1 shows the number of hospitals that claimed insurance for each sedative. When analyzed by year, a unique pattern was observed. In 2007, 168 hospitals made



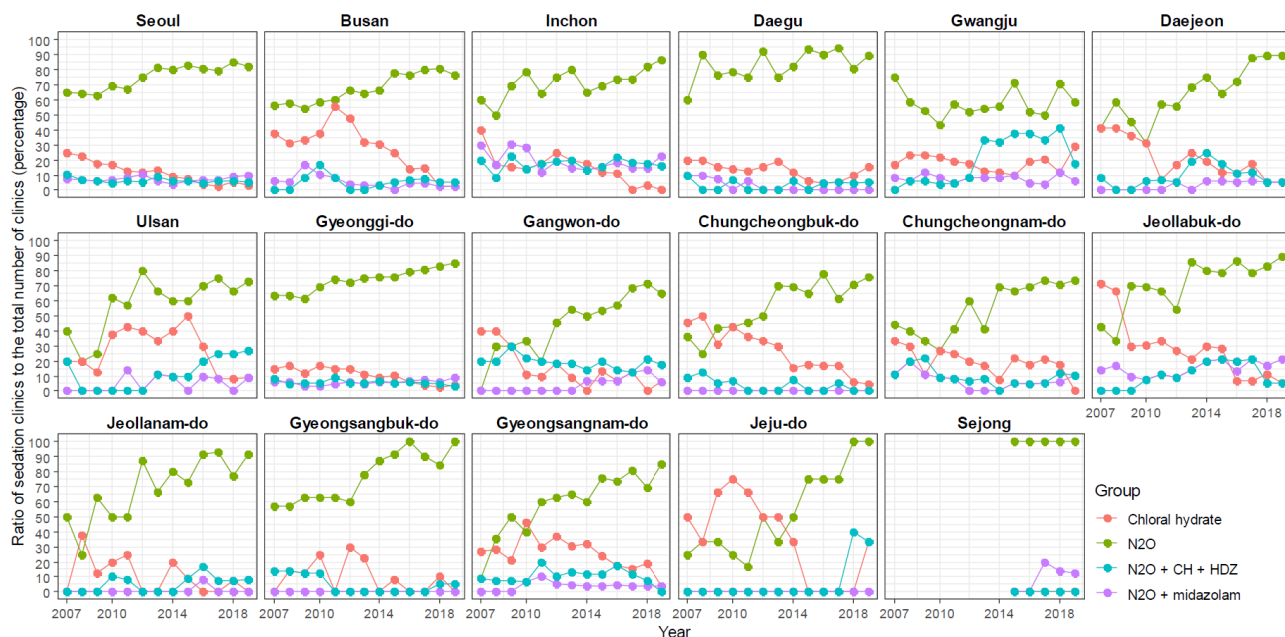


Fig. 5. Ratios of the number of hospitals that prescribed the main four types of sedatives for which insurance claims were filed to the total number of hospitals prescribing sedatives. The regional and yearly changes in South Korea's administrative districts are represented by the graphs. CH, chloral hydrate; HDZ, hydroxyzine; N<sub>2</sub>O, nitrous oxide.

claims for N<sub>2</sub>O alone, accounting for 55.6% of the 302 hospitals. However, the number of hospitals making claims for N<sub>2</sub>O alone increased every year, reaching 510 out of 614 hospitals in 2019, at a rate of 83.1%.

In contrast, the number of hospitals making claims for chloral hydrate decreased from 76 (25.1%) in 2007 to just 29 (4.7%) in 2019. The numbers of hospitals making claims for hydroxyzine or midazolam alone were 62 (20.5%) and 84 (27.8%), respectively, in 2007, but the rate decreased over time, with 84 (13.7%) and 74 (12.0%) hospitals making claims in 2019, respectively. The number of hospitals making claims for the combined use of N<sub>2</sub>O, chloral hydrate, and hydroxyzine, which was the second-highest in terms of the number of patients, increased from 27 (8.9%) in 2007 to 51 (9%) in 2017 but decreased to 38 (6.1%) in 2019 (Fig. 4).

The changes in the number of prescribing hospitals were divided into four categories: N<sub>2</sub>O-alone claims; chloral hydrate-alone claims; combined claims of N<sub>2</sub>O, chloral hydrate, and hydroxyzine; and combined claims of N<sub>2</sub>O and midazolam. The analysis of the proportion of insurance claim hospitals in South Korea by region and year showed a diverse picture. In populous areas,

such as Seoul and Gyeonggi-do, the trends were similar to those seen when analyzing the entire country. However, in Busan, Daejeon, Ulsan, Chungcheongbuk-do, Jeolla-buk-do, Gyeongsangnam-do, and Jeju-do, there was a significant decrease in the use of chloral hydrate. In Gwangju, Ulsan, and Gangwon-do, it can be seen that the proportion of combined claims of N<sub>2</sub>O, chloral hydrate, and hydroxyzine was high (Fig. 5).

## DISCUSSION

According to data provided by the Korean Statistical Information Service (<http://kosis.kr>), the percentage of people enrolled in South Korea's National Health Insurance in 2021 reached 100%. According to a previous study conducted from January 1, 2007 to September 30, 2019, a total of 786,003 patients received 1,649,688 sedative insurance claims in South Korean dental clinics [14].

In South Korea, there is no residency training program for dental anesthesiology. Dentists specializing in pediatric dentistry learn sedation techniques through

pediatric dentistry residency programs [15,16], while oral and maxillofacial surgeons receive education on sedation through their residency programs and by collaborating with anesthesiology departments. General dentists who have not gone through a specialized residency program can receive sedation education through workshops on intravenous or oral sedation methods organized by the Korean Dental Society of Anesthesiology or through various private channels [8].

In a 2014 survey targeting members of the Korean Society of Dental Anesthesiology, the proportion of dentists performing sedation by specialty was as follows: pediatric dentistry, 48.2%; oral surgery, 28.1%; and general practice, 21.1% [8]. Pediatric dentists mainly performed N<sub>2</sub>O inhalation sedation, N<sub>2</sub>O and oral sedation combination, and oral sedation alone, while oral surgeons and general practitioners mostly used midazolam intravenous sedation. Therefore, it can be inferred that N<sub>2</sub>O inhalation sedation (66.86%), hydroxyzine (34.18%), and chloral hydrate (16.04%), which were claimed in the most hospitals in Table 1, were mainly used for pediatric patients.

The same survey also reported that among all practitioners, general practitioners and pediatric dentists were treating more than seven patients per week. Pediatric dentists reported that chloral hydrate and hydroxyzine were the most commonly used oral sedatives [8]. Fig. 1 shows that the number of hospitals prescribing more than 10 sedatives per year is steadily increasing, and in Fig. 2, an increase in hospitals prescribing more than 500 cases after 2013 can be observed. Considering that pediatric dentistry is the main department in which sedatives are prescribed, it can be thought that the decrease in chloral hydrate use in pediatric dentistry led to an increase in N<sub>2</sub>O prescriptions [14].

In 2005, An et al. reported that 66% of the respondents of a survey targeting members of the Korean Academy of Pediatric Dentistry were performing sedation [9]. According to the data of the Korean Statistical Information Service (<http://kosis.kr>) (Table 2), there were 17,923 dental clinics in 2019, showing a slight difference

in the data by Chae et al. reported in 2020 (17,917 dental clinics) [17]. In 2019, there were 343 pediatric dental clinics, of which 226, i.e., 66%, were prescribing sedatives, accounting for more than one-third of the total 614 sedation facilities.

According to previous studies, the average age of patients undergoing sedation has been increasing, and the number of sedation cases in the 16–30-year age group has been steadily increasing as well [14]. However, the trend in insurance claims for sedation procedures is still similar to the trend for pediatric patients. The increase in the average age for sedation can be associated with the decrease in chloral hydrate usage and the use of midazolam and N<sub>2</sub>O. When the maximum dose of chloral hydrate is 1 g and a single dose is considered to be 50 mg/kg [18], it was impossible to achieve the desired sedation depth for patients weighing more than 20 kg. The trend in pediatric dental sedation in South Korea has shifted from deep sedation using chloral hydrate to moderate sedation using midazolam and N<sub>2</sub>O [5], which may have influenced the increase in the number of hospitals making claims for N<sub>2</sub>O (Fig. 4).

On looking at the classification of dental care institutions in South Korea, we can find dental hospitals and dental clinics where dentists serve as directors, as well as tertiary general hospitals and secondary general hospitals that are required by law to establish dental departments. Dental insurance claims are made at all these places, and in 2007, there were a total of 13,796 hospitals, with only 302 hospitals (2.18%) prescribing dental sedatives. This is a very low rate compared to the total number of dental hospitals. This figure increased slightly in 2019 when the total number of hospitals increased to 18,517, with 614 hospitals (3.31%) prescribing dental sedatives, an increase of just over 1%. Recently, there have been many reports of dental clinics administering sedatives without insurance claims, but the overall trend shows that a small number of dental clinics engaged in this practice. In a previous paper, the total number of sedative claims in 2007 was 14,128, which increased 20 times to 305,264 in 2018 [14]. However,



the number of dental hospitals prescribing sedatives only doubled from 302 to 614, and there was a trend of increasing dental hospitals with over 2,000 annual cases. This shows that dentists are not easily entering the dental sedation market. Similar international data was searched for, but it was difficult to find detailed information.

A diverse pattern was observed on analyzing the regional distribution of hospitals prescribing the top four drugs (N<sub>2</sub>O alone, chloral hydrate, N<sub>2</sub>O-chloral hydrate-hydroxyzine combination, and N<sub>2</sub>O-midazolam combination) by year in South Korea. However, the changing patterns in Seoul (25.9%) and Gyeonggi Province (33.5%), where a significant proportion of pediatric dental clinics are concentrated, are similar to the patterns in Fig. 4 (Fig. 5) [17].

As of 2019, the health insurance coverage rate was 36.9% for dental clinics and 27% for dental hospitals, meaning that approximately 70% of dental treatments are not covered by health insurance [19]. Therefore, this study only covered approximately 30% of the prescription claims in dentistry. Although this study was based on insurance claims data and might not fully reflect all situations in dentistry, it was confirmed that the overall trends in pediatric and adult dental sedation claims were not significantly different. Additionally, analysis of big data separately for the population under 14 years and the population aged 15 and older may further clarify the differences.

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**Minjae Lee:** Investigation, Methodology

**Seong In Chi:** Writing - original draft, Writing - review & editing

**Hyuk Kim:** Conceptualization, Data curation

**Kwang-Suk Seo:** Conceptualization, Supervision, Writing - original draft, Writing - review & editing

**CONFLICTS OF INTEREST:** The authors have no conflicts of interest to declare.

**DECLARATION:** This study used based from the Health Insurance Review and Assessment Service, and the results of the study are not related to the Health Insurance Review and Assessment Service and the Ministry of Health and Welfare.

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