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Original Article

# Analysis of Dental Antibiotic Prescriptions for Children and Adolescents in South Korea

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**Abstract**

Antibiotics are used for the prevention and treatment of infections. This study aimed to investigate the patterns of dental antibiotic prescription in children and adolescents. The Health Insurance Review and Assessment Service provided data on patients who visited medical institutions. It was categorized according to year, sex, age, insurance type, dental institution, and region. Chi-square tests, Fisher's exact tests, and one-way analyses of variance were performed. Statistical analyses were performed using SAS software (ver. 9.2; SAS Institute, Cary, NC, USA). Amoxicillin and cephalosporins, the most commonly used antibiotics, accounted for approximately 96% of the prescriptions. The younger the child, the more antibiotics were prescribed for trauma, pulpitis, and dental abscesses. However, closer to adolescence, the antibiotics were primarily prescribed to manage impacted teeth and periodontal problems. Antibiotics were prescribed for 3.13 days on average. There were significant differences in the prescription rates according to age, sex, type of insurance, type of medical institution, and region ($p < 0.05$). This study suggested that antibiotic prescriptions should be closely monitored to ensure appropriate usage of antibiotics. [J Korean Acad Pediatr Dent 2023;50(3):292-306]

**Keywords**

Antibiotics, Prescription rate, Big data, Health insurance review and assessment service database

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## Introduction

Many individuals suffer from bacterial infections. However, after penicillin's discovery in 1928, it became possible to prevent and treat bacterial infections by discovering and developing antibiotics[1]; due to bacteria's bacteriostatic and bac-

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tericidal effects[2,3].

However, the indiscriminate use of antibiotics often results in antibiotic resistance[2,4]. Antibiotic-resistant bacteria weaken and incapacitate an individual's immune system, causing social and economic losses[4-7]. The World Health Organization (WHO) has warned about this issue and urged countries to unite and improve their policies[8,9]. Studies have shown that approximately 25,000 people in Europe die yearly from antibiotic-resistant bacteria, and approximately 1.5 billion euros are paid for social expenses[6,7]. De Kraker et al.[10] reported that antibiotic-resistant bacteria could kill approximately 10 million people annually by 2050. According to data released by the Centers for Disease Control and Prevention (CDC) in 2019, approximately 2.8 million antibiotic-resistant infections occur annually in the United States alone, killing approximately 35,000 patients[11].

The misuse and overuse of antibiotics cause antibiotic resistance[7]. Antibiotic use in Korea decreased from 2016 to 2020[12]. Nevertheless, Korea is still one of the countries that use large amounts of antibiotics[5,12]. According to a survey by the Organization for Economic Cooperation and Development (OECD) member countries on antibiotic consumption, Korea ranked third from 2016 to 2019 and fourth in 2020[12]. Korea also had the second highest antibiotic consumption, according to a WHO survey of six countries in the West Pacific on antibiotic consumption from 2016 to 2018[5]. According to the WHO 2016 records, Korea consumed antibiotics at 27.68 Defined Daily Doses (DDD) per 1000 inhabitants per day. In contrast, the DDD per 1000 inhabitants of Canada, Germany, and Japan per day were 17.05, 11.49, and 14.19, respectively. Choe and Shin[13] reported that South Korea had considerably high antibiotic prescribing rates for children. Youngster et al.[14] also reported that South Korea had the highest prescription rate for children.

Antibiotics are the second most commonly used drugs after pain relievers in dentistry[2]. They are mainly used preoperatively to prevent endocarditis, infection after surgery, and to prevent or treat fascial space infection. However, some studies have shown that dentists prescribe antibiotics more frequently and for longer periods than medical doctors, and the rate of antibiotic prescription by dentists is increasing[15,16].

Studies in Korea have analyzed antibiotic prescription trends in dental institutions[2,17,18]. However, there were limitations, such as being studied in a single institution, studying only the antibiotics prescribed for specific illnesses, and studying adults only. To the best of our knowledge, no studies have previously investigated the trends in antibiotics prescribed for children by dental institutions in South Korea. Therefore, this study aimed to investigate and analyze antibiotic prescription trends and rates prescribed by domestic dental institutions for children and adolescents aged < 20 years between 2016 and 2020.

## Materials and Methods

This study was approved by the Medical Ethics Committee of the Yonsei University Wonju College of Medicine (CR321380).

### 1. Data source and study participants

This study used the data provided by the Health Big Data Hub of the Korean Health Insurance Review and Assessment Service. When people subscribe to national health insurance (NIH) and visit medical institutions, the Health Insurance Review and Assessment Service collects related data and establishes the NIH Service-National Cohort (NHIS-NSC). This study used data from the Pediatric and Adolescent Patient Dataset in NHIS-NSC from 2016 to 2020. It involved sampling 10% (about 1 million) of all pediatric and adolescent patients each year for 5 years. This sample was representative of the yearly change in population and gender because the data source already reflected it. Consequently, the medical information of approximately five million children and adolescents was included. The Pediatric and Adolescent Patient Dataset included data sampled annually based on the year and month of treatment and was data that had been de-identified[19]. These secondary data were sampled and organized for patients who received medical

treatment to reduce the time and cost of research. However, researchers required considerable time and effort due to the extensive and complex nature of the data[20].

This study was conducted on children and adolescents aged < 20 years who underwent dental treatment and were prescribed antibiotics in the Pediatric and Adolescent Patient Dataset (Fig. 1). The total number of prescriptions and patients was 72,965,103 and 4,702,363 from the Pediatric and Adolescent Patient Dataset, respectively. Among the total number of patients, 2,274,997 underwent 6,486,921 dental treatments between 2016 and 2020, of whom 207,024 received 307,249 antibiotic prescriptions.

### 2. Data analysis

When a patient was prescribed antibiotics several times by the dentist in a year, an error could have occurred that led to the calculation that he was prescribed antibiotics once when conducting the study based on the number of patients. Therefore, this study was conducted based on the total number of medical treatment activities. The variables included the patient's sex, age, prescription year, type of insurance, region, and classification of the medical institution. The age of the patients was divided into 0 - 4 years, 5 - 9 years, 10 - 14 years, and 15 - 19 years, and the region was divided into cities and rural areas based on the average population density of Korea provided by the National Statistical Office[21]. Accordingly, Seoul, Busan, Daegu, Incheon, Gwangju, Daejeon, Ulsan, Sejong, and Gyeonggi were categorized as cities, whereas Gangwon, Chungcheongbuk-do, Chungcheongnam-do, Jeollabuk-do, Jeollanam-do, Gyeongsangbuk-do, Gyeongsangnam-do, and Jeju were categorized as rural areas. Medical institutions were divided into hospitals and clinics. According to the type of insurance, participants were divided into those who subscribed to national insurance and those who received medical aid.

This retrospective cross-sectional study investigated antibiotic prescription rates and duration according to the above variables. In addition, the preferred antibiotics according to age and disease were also investigated.

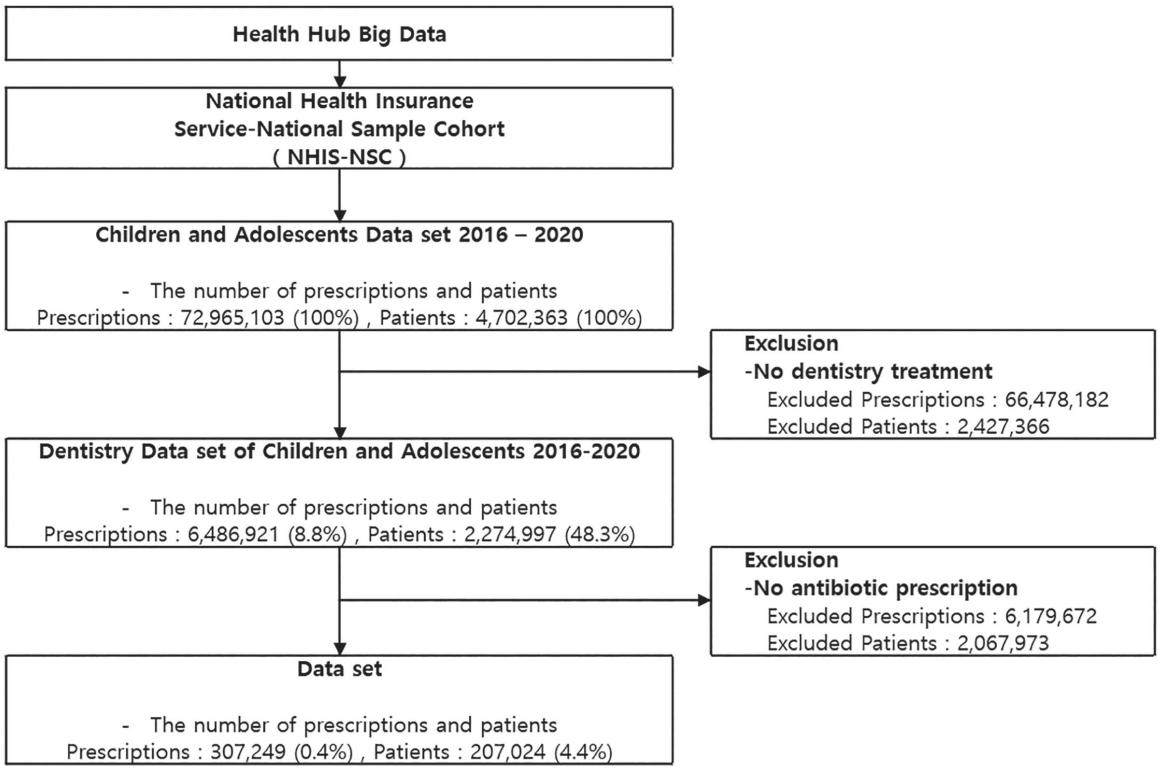


**Fig. 1.** Flowchart of the data set.

Chi-square tests were used to confirm the differences in antibiotic prescription rates according to variables, and a one-way analysis of variance was used to confirm the differences in the duration of antibiotic prescription. Fisher's exact test confirmed differences in antibiotic preferences according to age and disease status. All data were analyzed using SAS statistics (Ver. 9.2; SAS Institute, Cary, NC, USA).

## Results

From 2016 to 2020, 207,024 patients were prescribed antibiotics by their dentists. There were 100,412 males (48.50%) and 106,612 females (51.50%), with a higher proportion of females than males (Table 1, $p < 0.05$). The number of patients aged 0 - 4, 5 - 9, 10 - 14, and 15 - 19 years was 19,127 (9.24%), 48,290 (23.33%), 24,450 (11.81%), and 115,157 (55.62%), respectively, and significant differences were found according to age (Table 1, Fig. 2, $p < 0.05$).

Between 2016 and 2020, 307,249 antibiotics were prescribed by dentists. The number of prescriptions at 0 - 4, 5 - 9, 10 - 14, and 15 - 19 years was 25,630 (8.34%), 64,630 (21.04%), 32,925 (10.72%), and 184,064 (59.90%), respectively, and significant differences were found according to age (Table 2, $p < 0.05$). A total of 147,239 were males (47.92%), and 160,010 were females (52.08%). According to insurance type, 10,957 were Medicaid recipients (3.57%) and 296,292 NIH subscribers (96.43%). The average number of yearly Medicaid recipients between 2016 and 2020 was 1,498,951, accounting for approximately 2.9% of the total population of South Korea[21]. However, the Medicaid recipients' proportion of antibiotic prescriptions in this study was higher than 2.9%. By region, 219,067 patients were located in cities (71.30%), and 88,182 (28.70%) were in rural areas. The average yearly population of rural areas between 2016 and 2020 was 15,581,294, accounting for approximately 30% of the total population of South Korea[21]. However, in rural areas, the proportion of antibiotic prescriptions in this study was lower than 30%. Hospitals accounted for 41,798 (13.60%), and clinics accounted for 265,451 (86.40%) of antibiotic prescriptions, according to the classification of medical institutions. Significant differences were found in sex, type of insurance, region, and classification of medical institutions (Table 2, $p < 0.05$).

**Table 1.** The number of patients prescribed antibiotics in 2016 - 2020

| The number of dentistry patients | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year | | 2016 | 2017 | 2018 | 2019 | 2020 | 2016 - 2020 | |
| Dentistry patients | | 448,949 | 453,694 | 457,029 | 471,853 | 443,472 | 2,274,997 | |
| The number of patients prescribed antibiotics in dentistry | | | | | | | | |
| Year | | 2016 | 2017 | 2018 | 2019 | 2020 | 16 - 20 | *p*-value |
| Total | | 40,283 | 41,372 | 41,901 | 41,915 | 41,553 | 207,024 | |
| Gender | Male | 19,831 (49.23%) | 20,194 (48.81%) | 20,263 (48.36%) | 20,200 (48.19%) | 19,924 (47.95%) | 100,412 (48.50%) | < 0.05 |
| | Female | 20,452 (50.77%) | 21,178 (51.19%) | 21,638 (51.64%) | 21,715 (51.81%) | 21,629 (52.05%) | 106,612 (51.50%) | |
| Age | 0 - 4 | 3,826 (9.50%) | 4,036 (9.76%) | 3,760 (8.97%) | 3,776 (9.01%) | 3,729 (8.97%) | 19,127 (9.24%) | |
| | 5 - 9 | 8,659 (21.50%) | 9,187 (22.21%) | 9,758 (23.29%) | 10,249 (24.45%) | 10,437 (25.12%) | 48,290 (23.33%) | < 0.05 |
| | 10 - 14 | 4,861 (12.07%) | 4,688 (11.33%) | 4,867 (11.62%) | 5,019 (11.97%) | 5,015 (12.07%) | 24,450 (11.81%) | |
| | 15 - 19 | 22,937 (59.94%) | 23,461 (56.71%) | 23,516 (56.12%) | 22,871 (54.57%) | 22,372 (53.84%) | 115,157 (55.62%) | |

*p*-value from chi-square tests.

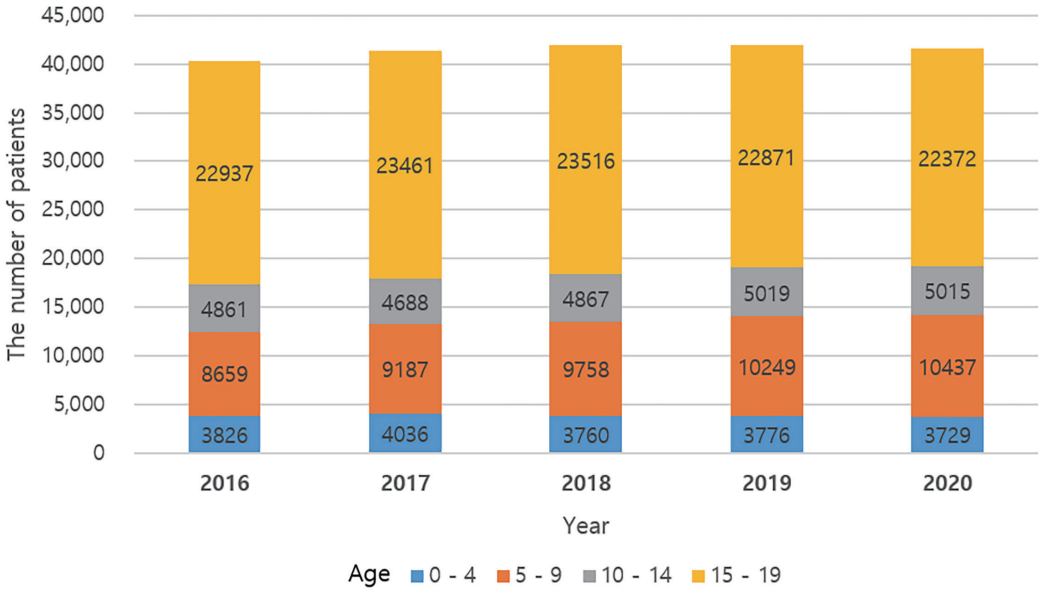


**Fig. 2.** Data on patients prescribed antibiotics in 2016 - 2020.

**Table 2.** Information about prescriptions

| Antibiotics prescriptions | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year | | 2016 | 2017 | 2018 | 2019 | 2020 | 2016 - 2020 | |
| Total | | 59,826 | 61,344 | 62,746 | 62,563 | 60,770 | 307,249 | |
| Antibiotic prescriptions according to variances | | | | | | | | |
| | | 2016 | 2017 | 2018 | 2019 | 2020 | 16 - 20 | *p*-value |
| Age | 0 - 4 | 5,095 (8.52%) | 5,407 (8.81%) | 5,104 (8.13%) | 5,023 (8.03%) | 5,001 (8.23%) | 25,630 (8.34%) | |
| | 5 - 9 | 11,511 (19.24%) | 12,267 (20.00%) | 13,099 (20.88%) | 13,740 (21.96%) | 14,013 (23.06%) | 64,630 (21.04%) | < 0.05 |
| | 10 - 14 | 6,658 (11.13%) | 6,206 (10.12%) | 6,489 (10.34%) | 6,780 (10.84%) | 6,792 (11.18%) | 32,925 (10.72%) | |
| | 15 - 19 | 36,562 (61.11%) | 37,464 (61.07%) | 38,054 (60.65%) | 37,020 (59.17%) | 34,964 (57.53%) | 184,064 (59.90%) | |
| Gender | Male | 29,212 (48.83%) | 29,464 (48.03%) | 29,905 (47.66%) | 29,845 (47.70%) | 28,813 (47.41%) | 147,239 (47.92%) | < 0.05 |
| | Female | 30,614 (51.17%) | 31,880 (51.97%) | 32,841 (52.34%) | 32,718 (52.30%) | 31,957 (52.59%) | 160,010 (52.08%) | |
| Type of Insurance | National Insurance | 57,333 (95.83%) | 58,998 (96.18%) | 60,478 (96.39%) | 60,575 (96.82%) | 58,908 (96.94%) | 296,292 (96.43%) | < 0.05 |
| | Medicaid | 2,493 (4.17%) | 2,346 (3.82%) | 2,268 (3.61%) | 1,988 (3.18%) | 1,862 (3.06%) | 10,957 (3.57%) | |
| Region | Cities | 42,317 (70.73%) | 43,530 (70.96%) | 44,916 (71.58%) | 44,872 (71.72%) | 43,432 (71.47%) | 219,067 (71.30%) | < 0.05 |
| | Rural | 17,509 (29.27%) | 17,814 (29.04%) | 17,830 (28.42%) | 17,691 (28.28%) | 17,338 (28.53%) | 88,182 (28.70%) | |
| Institution | Hospital | 7,937 (13.27%) | 8,351 (13.61%) | 8,641 (13.77%) | 8,772 (14.02%) | 8,097 (13.32%) | 41,798 (13.60%) | < 0.05 |
| | Clinic | 51,889 (86.73%) | 52,993 (86.39%) | 54,105 (86.23%) | 53,791 (85.98%) | 52,673 (86.68%) | 265,451 (86.40%) | |

*p*-value from chi-squared tests.

From 2016 to 2020, differences in antibiotic prescription rates were identified according to year, age, sex, insurance type, region, and classification of medical institutions (Table 3). It was confirmed that about 4.74% of the 6,486,921 dental treatments required antibiotics (Table 3). Females were prescribed more antibiotics than males, and the 15 - 19 age group had a higher antibiotic prescription rate than the other age groups. Medicaid recipients received more antibiotics than NIH subscribers. Rural areas had a higher antibiotic prescription rate than cities, and hospitals had a higher antibiotic prescription rate than clinics. There were significant differences in the antibiotic prescription rates according to year, age, sex, insurance, region, and classification of medical institutions (Table 3, $p < 0.05$).

As a result of investigating 307,249 dental antibiotic prescriptions from 2016 to 2020, the average number of days of antibiotic prescriptions was 3.13 (Table 4). The group aged 15 - 19 years had a longer antibiotic duration than the other age groups (Table 4, $p < 0.05$). NIH subscribers were prescribed antibiotics for longer than Medicaid recipients. Furthermore, antibiotics were prescribed for longer durations in cities than in rural areas and in hospitals compared to clinics. There were no significant differences in the number of days of antibiotic prescription according to sex. However, there were significant differences according to age, type of insurance, region, and classification of medical institutions (Table 4, $p < 0.05$).

An investigation of 307,249 antibiotic prescriptions received from dentists between 2016 and 2020 revealed that the most preferred antibiotic was amoxicillin, followed by cephalosporins (Table 5). Amoxicillin or cephalosporin antibiotics were used in 96.8% of the cases (Fig. 3). Amoxicillin was more frequently prescribed in younger age groups, and the proportion of cephalosporin antibiotics increased with age. Antibiotic preference significantly differed according to age (Table 5, $p < 0.05$).

**Table 3.** Antibiotic prescriptions rates

| | | Antibiotic prescriptions rate | | | | |
|---|---|---|---|---|---|---|
| | | Y | % | N | % | *p*-value |
| Total | | 307,249 | 4.74 | 6,179,672 | 95.26 | |
| Year | 2016 | 59,826 | 4.78 | 1,192,130 | 95.22 | |
| | 2017 | 61,344 | 4.85 | 1,202,372 | 95.12 | |
| | 2018 | 62,746 | 4.87 | 1,224,464 | 95.13 | < 0.001 |
| | 2019 | 62,563 | 4.49 | 1,331,054 | 95.51 | |
| | 2020 | 60,770 | 4.71 | 1,229,652 | 95.29 | |
| Age | 0 - 4 | 25,630 | 2.67 | 935,140 | 97.33 | |
| | 5 - 9 | 64,630 | 2.15 | 2,944,331 | 97.85 | < 0.001 |
| | 10 - 14 | 32,925 | 2.68 | 1,195,628 | 97.32 | |
| | 15 - 19 | 184,064 | 14.28 | 1,104,573 | 85.72 | |
| Gender | Male | 147,239 | 4.65 | 3,019,012 | 95.35 | < 0.001 |
| | Female | 160,010 | 4.82 | 3,160,660 | 95.18 | |
| Type of Insurance | National Insurance | 296,292 | 4.67 | 6,044,466 | 95.33 | < 0.001 |
| | Medicaid | 10,957 | 7.50 | 135,206 | 92.50 | |
| Region | Cities | 219,067 | 4.67 | 4,467,866 | 95.33 | < 0.001 |
| | Rural | 88,182 | 4.90 | 1,711,806 | 95.10 | |
| Institution | Hospital | 41,798 | 10.21 | 367,641 | 89.79 | < 0.001 |
| | Clinic | 265,451 | 4.37 | 5,812,031 | 95.63 | |

*p*-value from chi-squared tests.
Y: Number of antibiotic prescriptions; N: Other prescriptions.

**Table 4.** Duration of antibiotic prescription

| | | Duration of antibiotic prescriptions | | | |
|---|---|---|---|---|---|
| | | n | Av | SD | *p*-value |
| Total | | 307,249 | 3.13 | 1.29 | |
| Age | 0 - 4 | 25,630 | 2.95 | 1.04 | < 0.001 |
| | 5 - 9 | 64,630 | 2.87 | 1.04 | |
| | 10 - 14 | 32,925 | 3.00 | 1.25 | |
| | 15 - 19 | 184,064 | 3.27 | 1.27 | |
| Gender | Male | 147,239 | 3.13 | 1.25 | 0.30 |
| | Female | 160,010 | 3.12 | 1.20 | |
| Type of Insurance | National Insurance | 296,292 | 3.13 | 1.22 | < 0.001 |
| | Medicaid | 10,957 | 3.10 | 1.12 | |
| Region | Cities | 219,067 | 3.16 | 1.26 | < 0.001 |
| | Rural | 88,182 | 3.06 | 1.11 | |
| Institution | Hospital | 41,798 | 3.45 | 1.80 | < 0.001 |
| | Clinic | 265,451 | 3.08 | 1.10 | |

One-way ANOVA, *p*-values from the Bonferroni method.

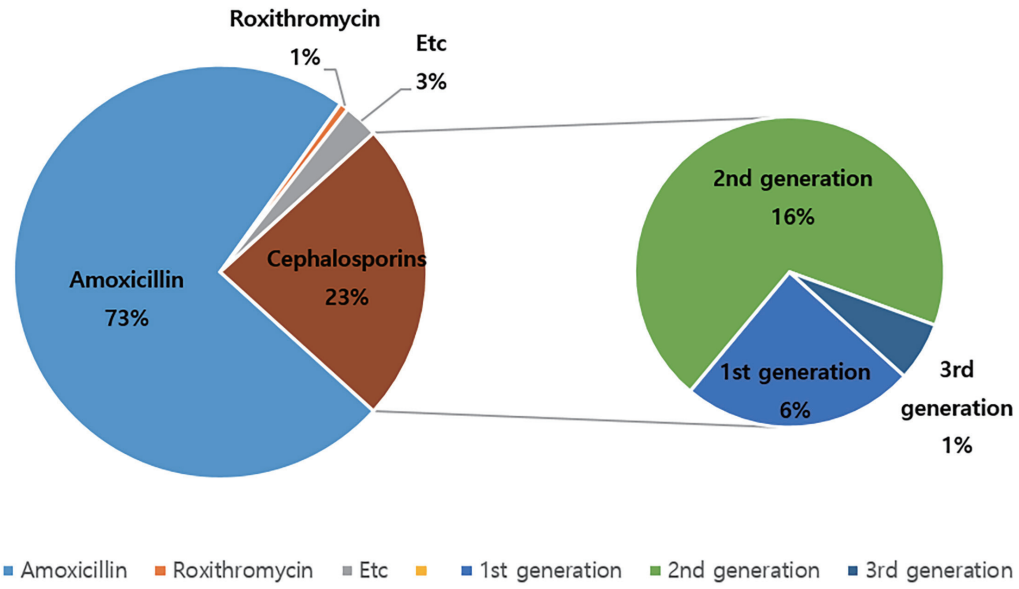


**Fig. 3.** Prescribed antibiotics in 2016 - 2020.

The condition for which dentists prescribed antibiotics was investigated. Pulpitis, dental abscesses, and dental caries accounted for a high proportion of cases before the age of 10 years (Table 5). However, the rate of antibiotic prescriptions for impacted teeth and periodontal disease increased after 10 years of age. In addition, the proportion of antibiotic prescriptions due to trauma in the 0 - 4-years-old group was relatively higher than in the other age groups. There was a significant difference in the number of antibiotic-prescribed diseases according to age (Table 5, $p < 0.05$).

**Table 5.** Preference of antibiotics and frequency of codes

| The number of antibiotics and codes according to age | | | | | |
|---|---|---|---|---|---|
| Age | | 0 - 4 | 5 - 9 | 10 - 14 | 15 - 19 |
| Total | | 25,630 | 64,630 | 32,925 | 184,064 |
| Antibiotics | 1 | Amoxicillin 21,966 (85.70%) | Amoxicillin 54,098 (83.70%) | Amoxicillin 24,001 (72.90%) | Amoxicillin 124,742 (67.77%) |
| | 2 | Cephalosporin 3,307 (12.90%) | Cephalosporin 9,285 (14.36%) | Cephalosporin 7,758 (23.56%) | Cephalosporin 52,505 (28.53%) |
| | 3 | Ofloxacin 69 (0.27%) | Ampicillin 269 (0.41%) | Roxithromycin 255 (0.77%) | Roxithromycin 1,658 (0.90%) |
| | 4 | Ampicillin 63 (0.25%) | Roxithromycin 209 (0.32%) | Metronidazole 180 (0.55%) | Metronidazole 986 (0.54%) |
| | 5 | Metronidazole 33 (0.13%) | Gentamicin 162 (0.25%) | Ampicillin 170 (0.51%) | lincomycin 781 (0.42%) |
| *p*-value | | < 0.05 | | | |
| Code | 1 | Pulpitis (K040) 7,086 (27.65%) | Dental abscess (K047) 15,947 (24.67%) | Impacted teeth (K011) 4,539 (13.79%) | Impacted teeth (K011) 89,469 (48.61%) |
| | 2 | Dental abscess (K047) 6,170 (24.07%) | Pulpitis (K040) 10,222 (15.82%) | Pulpitis (K040) 3,151 (9.57%) | Periodontitis (K053) 27,336 (14.85%) |
| | 3 | Caries of dentin (K021) 3,586 (13.99%) | Caries of dentin (K021) 6,693 (10.36%) | Dental abscess (K047) 2,952 (8.97%) | Periodontal abscess (K052) 12,275 (6.67%) |
| | 4 | Subluxation of tooth (S032) 936 (3.65%) | Primary teeth extraction (K006) 4,564 (7.06%) | Periodontitis (K053) 2,566 (7.79%) | Pulpitis (K040) 8,372 (4.55%) |
| | 5 | Lip laceration (S015) 873 (3.41%) | Impacted teeth (K011) 2,623 (4.06%) | Periodontal abscess (K052) 2,341 (7.11%) | Dental abscess (K047) 6,699 (3.64%) |
| *p*-value | | < 0.05 | | | |

*p*-value from Fisher's exact tests.

## Discussion

Antibiotics are used to prevent and treat infections. Antibiotics kill infectious microorganisms by inhibiting proliferation[2,3]. However, antibiotics can cause problems that render infectious microorganisms resistant to them[3]. This is a natural process by which infectious microorganisms adapt to antibiotics[3]. Antibiotic-resistant bacteria are more likely to develop after frequent antibiotic exposure[3]. Therefore, considering both antibiotics' effects and side effects, their use is recommended only in appropriate situations. Several studies and guidelines for the prescription of antibiotics have been published[2,5,7,9,12-18,22-32]. This study researched antibiotics prescribed by dentists for children and adolescents aged 0 - 19 years in Korea, which has not previously been covered in the literature.

The antibiotic prescription rate was approximately 4.74% after dental procedures performed between 2016 and 2020; this was lower than 5.7%, as shown in a previous study on adults, and lower than 6.5 - 8.5%, in an earlier study conducted in the Czech Republic[2,16]. Significant differences in antibiotic prescription rates were confirmed according to year, age, sex, region, classification by medical institutions, and insurance type. Cities had lower antibiotic prescription rates than rural areas; this could be attributed to the fact that children and adolescents in cities with good dental access often receive preventive care or checkups; however, children and adolescents in rural areas received more restorations or surgical treatments because of poor dental access[33]. These results were consistent with a previous study in which children and adolescents in rural areas that lacked access to medical institutions and thus lacked preventive

treatment were compared to those in cities[34]. Furthermore, a previous study showed that more antibiotics are desired and prescribed among older parents and parents with lower education[35]. Therefore, in rural areas with elderly guardians or low education, unnecessary antibiotic prescriptions may lead to higher prescription rates. Shin et al.[36] also reported that metropolitan regions had a lower antibiotic prescription rate than rural areas in South Korea.

Children and adolescents aged 5 - 9 years exhibited higher antibiotic prescription rates than those aged 0 - 4 years. Lim et al.[37] reported that oral health was worse in older pediatric patients, and they attributed this to the cumulative nature of dental caries. Therefore, the oral health of children aged 5 - 9 years could be worse than that of children aged 0 - 4 years before exfoliation of deciduous teeth. Consequently, more antibiotics could be prescribed for this age group. In addition, patients with NIH had a lower antibiotic prescription rate than Medicaid recipients. According to the Children's Oral Health Survey announced by the Ministry of Health and Welfare in December 2019, the group marked "low" on the economic status item had more carious teeth[38]. In other words, the poorer the economic condition, the poorer the oral health, and the more aggressive dental treatments and antibiotic prescriptions were required. The antibiotic prescription rate also differed depending on the classification of the medical institutions. Dental hospitals had a higher antibiotic prescription rate than dental clinics, consistent with previous studies conducted on adults[17,18]. According to Korea's medical system, treatment for mild diseases is carried out in clinics, whereas difficult diseases requiring specialized medical management are referred to hospitals. Therefore, hospitals may encounter more severe infections and situations requiring surgical treatment than do clinics, resulting in frequent antibiotic prescriptions. This is consistent with the findings of Choi et al.[39], which indicated that more surgical treatments were performed at dental hospitals than at dental clinics.

The average duration of antibiotic prescriptions was 3.13. In a previous study, Kim et al.[2] reported that the average duration of antibiotic prescription in dentistry is 3.40. However, their study was conducted at a single dental institution. In another study, Lee and Choi[18] reported that the average number of days of antibiotic prescription in dentistry was 3.06 for adults. There have been no previous dental studies on antibiotic prescriptions for children in Korea, but a medical study on antibiotics prescribed to children for acute upper respiratory tract infections was found, in which antibiotic prescriptions in pediatric adolescents averaged 3.08 days[40]. Moreover, as previously described, more antibiotics are desired and prescribed among older parents and parents with lower education[35]. As antibiotics were over-prescribed or prescribed unnecessarily to patients in rural areas and Medicaid recipients with elderly guardians or guardians with lower education, practitioners could prescribe antibiotics for a shorter duration. Thus, in this study, patients from rural areas and Medicaid recipients were prescribed antibiotics for shorter durations than were those from cities and NIH subscribers.

The most frequently prescribed antibiotics for children and adolescents in dental institutions in Korea were amoxicillin- and cephalosporin-based drugs. Amoxicillin accounted for approximately 73.2% of all antibiotic prescriptions, and cephalosporin-based antibiotics accounted for approximately 23.7% of all antibiotic prescriptions. In another study conducted on adults, Choi[17] reported that penicillin was the first choice, followed by metronidazole. Metronidazole is an antibiotic that acts on anaerobic bacteria. The International Association of Paediatric Dentistry (IAPD) announced that tooth extraction and root canal treatment could resolve most infections in children and adolescents. Removing the source of infection should be the first step, and antibiotic prescriptions are unnecessary, except in special cases[41]. This means that when infections were found, most were thought to be sufficient to be alleviated with amoxicillin- and cephalosporin-based antibiotics. Therefore, metronidazole was unnecessary for children and adolescents compared to adults, so its preference was low.

Orofacial infections are commonly attributed to bacteria such as gram-positive cocci and gram-negative

bacilli. In appropriate conditions, antibiotics contribute to controlling the infection along with surgical intervention by killing or inhibiting the growth of bacteria[42]. When prescribing antibiotics for dental infections in children and adolescents, amoxicillin is the first-choice drug because it offers broad gram-positive bacteria coverage with a low incidence of adverse effects[42,43]. In addition, it offers greater gram-negative coverage than does penicillin[44]. Amoxicillin can also be absorbed from the gastrointestinal tract and provide high serum concentrations, demonstrating high effectiveness against oral flora[43,45]. Cephalosporin can be considered an alternative for the management of odontogenic infections in children who are allergic to penicillin/amoxicillin[46]. For antibiotic prescriptions, the American Academy of Pediatric Dentistry (AAPD) recommends that the duration of the drug regimen be five days beyond the point of substantial improvement, regardless of the disease[30]. However, Aidasani et al.[28] conducted a systemic review and reported that no consensus regarding the duration of antibiotic therapy or prophylaxis was found.

This study confirmed that antibiotics were commonly prescribed for dental trauma in children aged 0 - 4 years and for periodontal disease as they got older (Fig. 4). This result was consistent with previous studies, which reported that the younger the age, the higher the frequency of dental trauma, and the higher the age, the higher the frequency of periodontal disease[47,48]. Lam et al.[47] reported that children aged 0 - 4 years presented with the highest number of dental trauma injuries, and Kassebaum et al.[48] reported that people aged < 15 years were not at a risk of developing severe periodontitis.

When dentists prescribed antibiotics, the disease was investigated. Antibiotics were mostly prescribed for pulpitis, periodontal disease, impacted teeth, and dental abscesses. However, according to the antibiotic prescription guidelines revised in 2022 by AAPD, an antibiotic prescription is unnecessary for pediatric and adolescent patients most of time[30]. In case of pulpitis, apical periodontitis, draining sinus tract, and localized intraoral swelling, antibiotic therapy is not indicated or needed if the dental infection is confined to the pulpal tissue or the

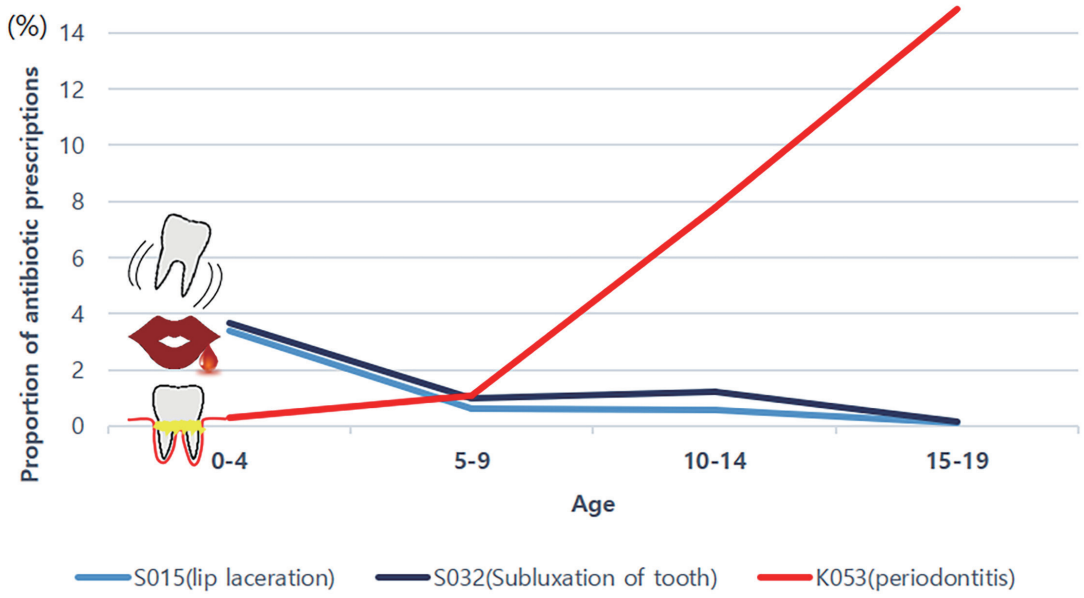


**Fig. 4.** Proportion of antibiotic prescriptions according to age in 2016 - 2020.

immediate surrounding tissue. However, oral wounds contaminated by extrinsic factors should be managed with systemic antibiotics. Antibiotics could be beneficial because they supplement the natural host resistance to killing bacteria. Acute facial swelling also needs antibiotics, which medical management with intravenous antibiotics could help cure more rapidly alongside surgical intervention; metronidazole could be considered for anaerobic coverage. Cases of tooth avulsion need antibiotics. Drugs such as amoxicillin are beneficial for avulsed permanent incisors due to their effectiveness against oral flora. Periodontitis commonly does not warrant antibiotics, but aggressive periodontitis does. Periodontal patients with systemic diseases should be given antibiotics because their immune systems are compromised and they cannot control the growth of periodontal pathogens. Antibiotics are not warranted for viral infections since these medications are only effective against bacteria. In the case of salivary gland infections, antibiotics are indicated. Amoxicillin/clavulanate is the drug of choice due to its extensive staphylococcal and streptococcal coverage, the most common etiologic agents[30].

The IAPD guidelines also report that oral infections in children and adolescents can commonly be resolved with tooth extraction and root canal treatment, and antibiotic prescriptions are unnecessary except in special cases[41]. Goel et al.[25] recommended prescribing only analgesic and anti-inflammatory drugs when no clear signs of infection progression, such as fever or facial swelling, were found. Therefore, further research is needed to confirm whether patients prescribed antibiotics for pulpitis, periodontitis, and dental abscesses in this study were prescribed appropriately.

This study had several limitations. The NHIS-NSC used in this study included only data on covered benefits and did not include medical treatment for non-covered benefits under the insurance plan, such as orthodontic extractions. In other words, prescriptions for non-covered benefits could not be explained by the results of this study. The inaccuracy of the investigated diseases is also a limitation of this study. This was because when dentists entered disease names after patient treatment, there were cases in which dentists arbitrarily or habitually entered disease names differently. Another limitation is that the study is confined to showing the trends of antibiotic prescriptions without verifying the overuse or misuse of antibiotics. The American Medical Association (AMA) defined the two terms as such: 'overuse' occurs when the potential for harm exceeds the possible benefit, whereas 'misuse' occurs when an appropriate service has been selected but a preventable complication occurs and the patient does not receive the service's full potential benefit[49]. However, antibiotic resistance takes time to identify. Hence, this cross-sectional study was also unable to document if any harm or complications, such as antibiotic resistance, arose from the antibiotics prescribed. In addition, factors affecting antibiotic prescription, such as systemic disease and its severity, could not be identified and included in the study. Finally, the distinction between cities and rural areas was limited because the Review and Assessment Service data were based on the administrative district. Thus, it included cities such as Jinju and Changwon in Gyeongsangnam-do, but data on Jinju and Changwon could not be obtained as city data, and only data covering the entire Gyeongsangnam-do area could be obtained.

Despite these limitations, this study used NHIS-NSC data representing the entire Korean population to investigate antibiotics prescribed by dentists to children and adolescents. Therefore, these representative results can be used to establish national policies to reduce antibiotic use.

## Conclusion

This study analyzed the dental prescription of antibiotics prescribed to children and adolescents between 2016 and 2020. A significant relationship was observed between socioeconomic factors and antibiotic prescription rates. In addition, this study highlighted the latest trends in antibiotic prescriptions and emphasized the need for close monitoring to ensure the appropriate use of antibiotics.

## Conflicts of Interest

The authors have no potential conflicts of interest to disclose.

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국문초록

# 소아 청소년에 대한 한국 치과에서의 항생제 처방 분석

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항생제는 감염의 예방과 치료를 위해 사용된다. 이 연구는 치과에서 소아·청소년에게 처방하고 있는 항생제 동향을 분석하기 위해 수행됐다. 건강보험심사평가원에서 2016년부터 2020년까지 치과의료기관을 방문한 소아·청소년 환자들의 정보를 제공받았고, 연도, 성별, 나이, 가입된 보험 종류, 의료기관의 종별 분류, 지역에 따라 범주화하여 통계적으로 분석하였다. Amoxicillin과 Cephalosporin계열 항생제가 전체 항생제 처방에서 약 96%를 차지하여, 치과에서 가장 많이 처방되는 것으로 나타났다. 그리고 낮은 연령일수록 치과적 외상, 치수염, 치성 농양을 이유로 항생제가 처방되는 빈도가 높았으며, 연령이 높을수록 매복치, 치주 문제로 항생제를 처방하는 빈도가 높아졌다. 항생제는 평균적으로 3.13일 처방되었고 항생제 처방률은 나이, 성별, 가입된 보험 종류, 의료기관의 종별 분류, 지역에 따라 유의미한 차이를 보였다($p < 0.05$). 이 연구는 항생제 처방에 다양한 사회, 경제학적 요소가 영향을 주는 것을 확인해 주었고, 따라서 항생제 처방에 대해 주도면밀한 관찰 및 감시가 필요할 것으로 생각된다. [J Korean Acad Pediatr Dent 2023;50(3):292-306]

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