Profile of dental use for diseases of pulp and periapical tissues under the National Health Insurance system in Taiwan in 2020

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Abstract
Background/purpose: The penetration rate of National Health Insurance (NHI) of Taiwan is as high as 99.9\%. This study investigated the profile of dental use for diseases of pulp and periapical tissues under the NHI system of Taiwan in 2020.

Materials and methods: Data on the population and medical records of the NHI system were obtained from the websites of Ministry of the Interior and the NHI Administration, respectively. The dental patient data were divided into 18 age groups to analyze dental treatment records claimed in 2020.

Results: Under the NHI system in Taiwan in 2020, the dental use rate for treatment of diseases of pulp and periapical tissues had the highest peak (12.76\%) in the 5–9-year age group. It dropped abruptly to the lowest point (2.71\%) in the 10–14-year age group, raised gradually with increasing age, reached to the second and third highest peaks in the 70–74-year (10.75\%) and 65–69-year (10.72\%) age groups, respectively, and finally declined to 4.40\% in the greater than 85-year age group. Furthermore, the number of out-patient visits per 1000 people and the medical expenses per person for diseases of pulp and periapical tissues among the same 18 age groups also showed a similar trend to the dental use rate.

Conclusion: Diseases of pulp and periapical tissues are still the main diseases of the oral cavity. From a cost-effectiveness viewpoint, Taiwan government should develop a better oral health
Introduction

Pulp diseases, including acute pulpitis, chronic pulpitis, pulp degeneration, and pulp necrosis, are a series of dental diseases that occur in the pulp tissue. The pulp is located in the pulp chamber and root canal, which is rich in sensory nerves. When the pulp is inflamed, it may cause severe pain or toothache. People of any age may suffer from pulp diseases. Dental caries which is not treated properly may further develop into pulp diseases. The most important causative factor of pulp diseases is bacterial infection due to dental caries, followed by tooth trauma. In addition, the long-term tooth wear may also induce pulp diseases. Although the symptoms of various pulp diseases vary slightly, the main one is pain. Among them, acute pulpitis mainly produces spontaneous and severe pain and chronic pulpitis may produce intermittent and dull pain. The pain of acute or chronic pulpitis may also elicited by high or low temperature stimulation. If the pulp diseases are not treated in time, they may further develop into diseases of the periapical tissues. The treatment principle of diseases of pulp and periapical tissues is to remove the infected pulp tissue, clean and enlarge the root canals, and then fill the root canals with appropriate filling materials to prevent reinfection, which is called nonsurgical root canal treatment. However, surgical intervention may also be required if the nonsurgical root canal treatment fails.

To understand the oral cavity status or diseases of our people, oral examination is the most direct method, but there are still problems that may influence the results of oral examination such as inspection methods, sampling methods, sampling ratios, and additional budgets. Fortunately, the National Health Insurance (NHI) was implemented in Taiwan in 1995, and the penetration rate has reached 99.9% of the entire population. Since the implementation of NHI, the patients’ medical records, including the types of diseases, have been stored in the NHI database. Therefore, we have the opportunity to extract the medical records from the NHI database and to analyze the dental use for diseases of pulp and periapical tissues and their expenses for the associated dental treatments. We hope that the results of this study can be used as a reference for the formulation of a better national oral health care policy in the near future.

Materials and methods

This study adopted the methods of the secondary data analysis. The population data in the mid-2020 of Taiwan were obtained from the website of Ministry of the Interior. For diseases of pulp and periapical tissues under the NHI system, the dental treatment records, including the numbers of patients, outpatient visits and their associated medical expenses were obtained from the website of the NHI Administration. This study only investigated and analyzed dental treatment records for diseases of pulp and periapical tissues claimed in 2020 in Taiwan.

In this study, the dental patient data were divided into 18 age groups (0–4, 5–9, 10–14, 15–19, 20–24, 25–29, 30–34, 35–39, 40–44, 45–49, 50–54, 55–59, 60–64, 65–69, 70–74, 75–79, 80–84, and ≥85 years) in order to match the 18 age groups published by the Ministry of the Interior. All the patients of the entire population were used as a group for comparison. According to the dental patients who received dental services under the NHI system in 2020, the dental use rate, the mean numbers of outpatient visits per patient, and the mean medical expense NHI points per patient were analyzed among the 18 age groups and all the patients for diseases of pulp and periapical tissues, as well as all the patients for all oral diseases. The dental use rate of patients in each age group was calculated by dividing the number of patients in each age group to the total population of the same age group. This study further compared the dental use rates of patients in each age group and in the overall population, the mean numbers of out-patient visits per patient, and the mean medical expense NHI points per patient in each age group of patients in Taiwan in 2020.

Results

The numbers and their proportions of the population, the patients, the out-patient visits, and the medical expenses for diseases of pulp and periapical tissues in the 18 age groups under the NHI system in Taiwan in 2020 are shown in Table 1. The population of 2020 was represented by those in the 10–14-year age group, raised gradually with increasing age, and reached to the first and second highest peaks in the 55–59-year (9.35%) and 60–64-year (9.22%) age groups, respectively. Then, the numbers of patients decreased subsequently in the older age groups and finally reached to the lowest point of 0.97% of the total patients (Table 1 and Fig. 1).
In terms of dental patients’ out-patient visits for diseases of pulp and periapical tissues, the total number of out-patient visits was 3,397,432. The number of out-patient visits had a small peak (6.78% of the total out-patient visits) in the 5–9-year age group. The number of out-patient visits decreased suddenly to 1.28% of the total out-patient visits.

Table 1 The numbers and their proportions of the population, the patients, the out-patient visits, and the medical expenses for diseases of pulp and periapical tissues in the 18 age groups under the National Health Insurance (NHI) system in Taiwan in 2020.

| Age (year) | Population a | Patients | Out-patient visits | Medical expenses |
|------------|---------------|----------|--------------------|------------------|
|            | Number (%)    | Number   | Number (%)         | Number (%)       |
| 0–4        | 950,551.5     | 4.03     | 18,589             | 0.96             |
| 5–9        | 1,041,754     | 4.42     | 132,958            | 6.78             |
| 10–14      | 994,568       | 4.22     | 26,942             | 1.49             |
| 15–19      | 1,204,283.5   | 5.11     | 52,747             | 2.92             |
| 20–24      | 1,504,494     | 6.38     | 84,276             | 4.67             |
| 25–29      | 1,603,533.5   | 6.80     | 98,299             | 5.45             |
| 30–34      | 1,589,037.5   | 6.74     | 108,052            | 5.99             |
| 35–39      | 1,929,609.5   | 8.18     | 138,411            | 7.67             |
| 40–44      | 1,995,448.5   | 8.46     | 157,007            | 8.70             |
| 45–49      | 1,767,772.5   | 7.50     | 146,012            | 8.10             |
| 50–54      | 1,810,394.5   | 7.68     | 158,189            | 8.77             |
| 55–59      | 1,826,208.5   | 7.74     | 168,644            | 9.35             |
| 60–64      | 1,667,302     | 7.07     | 166,337            | 9.22             |
| 65–69      | 1,412,678     | 5.99     | 151,376            | 8.39             |
| 70–74      | 851,257.5     | 3.61     | 91,522             | 5.07             |
| 75–79      | 599,063.5     | 2.54     | 53,981             | 2.99             |
| 80–84      | 436,019       | 1.85     | 32,784             | 1.82             |
| >85        | 398,203       | 1.69     | 17,519             | 0.97             |
| Overall    | 23,582,178.5  | 100      | 1,803,645          | 100              |

Overall (16.28% b) (8.18% b) (14.36% b)

All oral diseases — — 11,079,061 — 41,516,897 — 45,746,606,483 —

a The population in mid-2020 = (population at the end of 2020 + population at the end of 2019)/2.
b The proportion of each item for diseases of pulp and periapical tissues to each item for all oral diseases.

Figure 1 The changing trend of proportions of the population, the patients, the out-patient visits, and the medical expenses for diseases of pulp and periapical tissues in the 18 age groups under the National Health Insurance (NHI) system in Taiwan in 2020.
elevated with increasing age, reached to the first and second highest peaks in the 55–59-year (9.51%) and 60–64-year (9.42%) age groups, respectively, reduced again in the older age groups, and finally declined to the lowest point of 0.96% in the greater than 85-year age group (Table 1 and Fig. 1).

In terms of medical expense NHI points for the dental patients with diseases of pulp and periapical tissues, the total medical expenses were 6,569,977,037 NHI points. It should be noted that the value of one NHI point is settled quarterly, and one NHI point fluctuates around 0.8–1.2 NT dollars. The medical expense NHI points had a small peak (6.33% of the total medical expense NHI points) in the 5–9-year age group. It decreased abruptly to a relatively lower point of 1.11%, raised gradually with increasing age, reached to the first and second highest peaks in the 40–44-year (9.38%) and 55–59-year (9.33%) age groups, respectively, reduced again in the older age groups, and finally dropped to the lowest point of 0.69% in the greater than 85-year age group (Table 1 and Fig. 1).

Furthermore, for all oral diseases in the NHI system, the total numbers of all dental patients and their out-patient visits were 11,079,061 and 41,516,897, respectively. The total medical expenses per person for diseases of pulp and periapical tissues were 279 NHI points in overall. The medical expense NHI points had a small peak (221.07) in the 5–9-year age group. It reduced abruptly to a lower point (43.61) in the 10–14-year age group, elevated gradually with increasing age, reached to the second and third highest peaks in the 70–74-year (209.14) and the 65–69-year (207.99) age groups, respectively, and finally decreased to 81.51% in the greater than 85-year age group (Table 2 and Fig. 2).

The number of out-patient visits per 1000 people for diseases of pulp and periapical tissues was 144.07 in overall. This number had the highest peak (221.07) in the 5–9-year age group.

The dental use indicators of National Health Insurance (NHI) for diseases of pulp and periapical tissues in the 18 age groups under the NHI system in Taiwan in 2020 are shown in Table 2.

### Table 2: The dental use indicators of National Health Insurance (NHI) for diseases of pulp and periapical tissues in the 18 age groups in Taiwan in 2020.

| Age (year) | Dental use rate (%) | Number of out-patient visits per 1000 people | Medical expenses per person (NHI points) | Number of out-patient visits per patient | Medical expenses per patient (NHI points) | Medical expenses per out-patient visit (NHI points) |
|------------|---------------------|---------------------------------------------|----------------------------------------|----------------------------------------|----------------------------------------|----------------------------------------|
| 0–4        | 1.96                | 34.35                                       | 83                                     | 1.76                                   | 4258                                   | 2424                                    |
| 5–9        | 12.76               | 221.07                                      | 399                                    | 1.73                                   | 3126                                   | 1805                                    |
| 10–14      | 2.71                | 43.61                                       | 73                                     | 1.61                                   | 2695                                   | 1674                                    |
| 15–19      | 4.38                | 77.87                                       | 157                                    | 1.78                                   | 3580                                   | 2014                                    |
| 20–24      | 5.60                | 101.68                                      | 209                                    | 1.82                                   | 3723                                   | 2051                                    |
| 25–29      | 6.13                | 113.21                                      | 240                                    | 1.85                                   | 3909                                   | 2117                                    |
| 30–34      | 6.80                | 128.32                                      | 275                                    | 1.89                                   | 4042                                   | 2142                                    |
| 35–39      | 7.17                | 135.71                                      | 289                                    | 1.89                                   | 4031                                   | 2131                                    |
| 40–44      | 7.87                | 149.82                                      | 309                                    | 1.90                                   | 3927                                   | 2062                                    |
| 45–49      | 8.26                | 158.79                                      | 319                                    | 1.92                                   | 3860                                   | 2008                                    |
| 50–54      | 8.74                | 168.36                                      | 329                                    | 1.93                                   | 3763                                   | 1953                                    |
| 55–59      | 9.23                | 176.98                                      | 336                                    | 1.92                                   | 3635                                   | 1897                                    |
| 60–64      | 9.98                | 192.02                                      | 355                                    | 1.92                                   | 3556                                   | 1847                                    |
| 65–69      | 10.72               | 207.99                                      | 371                                    | 1.94                                   | 3464                                   | 1785                                    |
| 70–74      | 10.75               | 209.14                                      | 358                                    | 1.95                                   | 3328                                   | 1711                                    |
| 75–79      | 9.01                | 172.40                                      | 283                                    | 1.91                                   | 3145                                   | 1644                                    |
| 80–84      | 7.52                | 141.33                                      | 222                                    | 1.88                                   | 2952                                   | 1571                                    |
| ≥85        | 4.40                | 81.51                                       | 114                                    | 1.85                                   | 2593                                   | 1399                                    |
| All oral   | 7.65                | 144.07                                      | 279                                    | 1.88                                   | 3643                                   | 1934                                    |
| Total medical expenses (NHI points) | 1740 | 1760.52 | 1940 | 3.75 | 4129 | 1102 |
The number of out-patient visits per patient for diseases of pulp and periapical tissues was 1.88 in overall. This number fluctuated between 1.61 and 1.95 among the 18 age groups and had the highest peak in the 70–74-year age group (1.95) (Table 2). Moreover, the medical expense per patient for diseases of pulp and periapical tissues was 3643 NHI points in overall. This medical expense per patient altered between 2593 and 4258 NHI points among the 18 age groups with the highest peak being in the 0–4-year age group (4258 NHI points) and the lowest point being in the greater than 85-year age group (2593 NHI points) (Table 2).

In addition, the medical expense per out-patient visit for diseases of pulp and periapical tissues was 1934 NHI points in overall. This medical expense per out-patient visit varied from 1399 to 2424 NHI points among the 18 age groups with the highest peak being in the 0–4-year age group (2424 NHI points) and the lowest point being in the greater than 85-year age group (1399 NHI points) (Table 2).

Furthermore, for all oral diseases in the NHI system, the dental use rate, the number of out-patient visits per 1000 people, and the number of out-patient visits per patient were 46.98%, 1760.52, and 3.75, respectively. Their medical expense per person, the medical expense per patient, and the medical expense per out-patient visit were 1940, 4129, and 1102 NHI points (Table 2).

Discussion

The NHI system of Taiwan began in March 1995. More than 99.9% of the population is covered by this insurance system. By accessing the database of the NHI Administration, we can study the epidemiology of various oral and dental diseases in different age groups of patients in Taiwan. In this study, we focused on the profile of dental use for diseases of pulp and periapical tissues under the NHI system in Taiwan in 2020.

According to the 2020 population data, we found that the younger age groups (0–24 years of age) had smaller populations among the age groups before the age of 24 years. The population of the 0–4-year age group (950,551.5, 4.03%) was less than half of the population of the 35–39-year age groups (1,929,609.5, 8.18%) and those of the 40–44-year age group (1,995,448.5, 8.46%) (Table 1). This means that the phenomenon of a low birthrate in Taiwan is a long-term and serious population problem. On the other hand, the population over the 65 years of age reached to 15.68% of the total population. According to the definition that a country whose population over the 65 years of age greater than 14% of the total population is called an aged society, Taiwan has already entered into the aged society. Therefore, the research on the epidemiology in Taiwan should consider both the low birthrate and aged society issues. This study divided the whole population into the 18 age groups and calculated their dental use rates. This design could make us to understand the dental use rates in the children and in the elderly people.

For diseases of pulp and periapical tissues, the numbers and their proportions of the patients, the out-patient visits, and the medical expenses among the 18 age groups showed a similar trend. The above parameters increased from the low point in the 0–4-year age group to a small peak in the 5–9-year age group, and then decreased abruptly to a lower point in the 10–14-year age group (Table 1 and Fig. 1). However, these parameters increased again to another peak in the 55–59-year age group, and declined subsequently in the older age groups. These findings indicate that the 5–9 years of age is the peak period for treatments of the pulp and periapical tissue diseases of the deciduous teeth, while the 50–59 years of age is the peak period for treatments of the pulp and periapical tissue diseases of the permanent teeth. Root canal treatment is a basic part of the comprehensive dental care. Previous studies showed that the incidence of root canal treatment...
increases with the age of the people, and the incidence is 3–6% for the younger adults and 18–20% for the patients older than 60 years of age. The highest peak for root canal treatment of all teeth is located in the 55–64-year age group.

This study presented the similar results that for either the primary or permanent dentition stage, the number of patients and their out-patient visits and the medical expenses under the NHI system all increased with age. In fact, the medical expenses for endodontic-related diseases under the NHI system are used for both nonsurgical root canal treatment and surgical treatment of periapical lesions, although the nonsurgical root canal therapy is still the main treatment covered in the NHI system. The numbers of patients and their out-patient visits and medical expenses for disease of pulp and periapical tissues were 16.28%, 8.18% and 14.36% of the corresponding data for all oral diseases in the NHI system, respectively. These findings indicate that diseases of pulp and periapical tissues are still the main diseases of the oral cavity. Our previous studies also confirmed that dental caries, periodontal diseases, and diseases of pulp and periapical tissues are the three main diseases of the oral cavity in Taiwan.

In terms of dental use indicators calculated by using the population as the denominator, the dental use rate, the number of out-patient visits per 1000 people, and the medical expenses per person for diseases of pulp and periapical tissues among the 18 age groups also showed a similar trend. The above parameters increased from the low value in the 0–4-year age group to the highest peak in the 5–9-year age group, and then dropped abruptly to a lower point in the 10–14-year age group. However, these values raised gradually to another peak in the 65–69-year or 70–74-year age group, and declined subsequently in the older age groups (Table 2 and Fig. 2). These findings indicate that the incidence of endodontic-related diseases of the deciduous teeth and their associated medical expenses for children are higher than the incidence of endodontic-related diseases of the permanent teeth and their related medical expenses for certain age groups of adults or the elderly. In fact, diseases of pulp and periapical tissues are the sequela of further deterioration of dental caries. This indirectly reflects the fact that the dental caries problem of our children may be worse than that of adults or the elderly. In contrast, the number of patients with diseases of pulp and periapical tissues in the 0–4-year age group in the NHI system was very few (only 1.03% of all patients), but their medical expenses per patient or medical expenses per out-patient visit were the highest among all the other age groups. This means that when pediatric patients, especially 0–4-year-old children, have endodontic-related diseases, they usually need more medical expenses because of the seriousness of their diseases of pulp and periapical tissues or the difficulties in treatments of these pediatric patients in the 0–4-year age group. These pediatric patients of the smaller age are often from disadvantaged groups, possibly low socioeconomic status families, cross-generational parenting families or families in which the primary caregivers lack oral health awareness. Therefore, our government should plan a more effective oral health care program for children in the near future.

In this study, we found that the dental use rate for all oral diseases among the entire population in Taiwan in 2020 was 46.98%. This dental use rate was lower than that (70%) reported in Denmark in 2003. However, a previous study showed that the overall dental use rate of patients older than 5 years of age in Taiwan in 2006 was 40.7%. This means an increase in the number of people who receive dental treatment under the Taiwan’s NHI system in 2020. In fact, the dental use rate of a country, region or ethnic group is affected by multiple factors. In addition to oral health status, other factors such as oral health awareness, popularity of oral health education, medical culture, health insurance system, economic status of individual families, and accessibility of dental care all directly affect the decision of a dental patient to seek for dental care.

Our previous study found that the 5–9-year-old children had the highest dental use rate (80.30%) for all oral diseases, followed by the 10–14-year-old children (57.19%) in Taiwan in 2020. These two dental use rates (80.30% and 57.19%) were even higher than that (46.98%) for all oral diseases of the entire population. In addition to the high penetration rate of Taiwan’s NHI and the increased public’s emphasis on oral health, such a high dental use rate may be due to the Taiwan’s oral health policy that conducts a comprehensive oral examination for every elementary or middle school student. The students with detected dental or oral diseases are advised and referred to see their dentists for further dental treatment.

In addition, we also found that the dental use rate for diseases of pulp and periapical tissues among the entire population in Taiwan in 2020 was 7.65%. This means that on average, one out of six persons who receive dental treatment under the NHI system is due to diseases of pulp and periapical tissues. However, because of the long-term lack of awareness and behavior for oral health care among Taiwanese people, diseases of pulp and periapical tissues still seriously damage the oral health of our people. Since endodontic-related diseases are the sequela of the deterioration of dental caries, in addition to reducing the national dental caries rate, oral health policy should encourage dental patients with dental caries to actively seek for dental treatment to increase the dental use rate for dental caries, thereby to prevent dental caries from deteriorating into endodontic-related diseases and to reduce the dental use rate due to the endodontic-related diseases. Reducing endodontic-related diseases will further decrease the medical expenses for affected teeth, either by the patients or by the insurance. Therefore, from a cost-effectiveness viewpoint, Taiwan’s oral health policy should continue to promote the development of oral health care for all citizens. Furthermore, it is also urgent to establish a professional team for oral health care and cultivate professional manpower with ability of oral health care, especially those with special ability for caring small pediatric patients with oral diseases.

Declaration of competing interest

The authors have no conflicts of interest relevant to this article.
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