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Original Article

Trends of dental service utilization and expenditure in Taiwan from 2000 to 2020

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Abstract *Background:* /purposeSince 1995, Taiwan's National Health Insurance (NHI) has offered a comprehensive dental coverage to over 99 % of the population. This study mainly analyzed the dental service utilization and expenditure trends by the gender, age, and service type and evaluated the resource allocation across different demographics from 2000 to 2020.
Materials and methods: Nationwide NHI administrative data were used to assess the dental visit rates, average visits per user, and per capita expenditure by the gender, age, and 11 service categories for the years 2000, 2005, 2010, 2015, and 2020. The analysis accounted for the fluctuations in the point value within the global budget system and calculated the dental expenditure across the demographic groups and service types.
Results: The dental visit rates increased across all demographics, with the most substantial growth in the 0–14 age group (37.0 % in 2000 to 66.9 % in 2020). However, the visit rates for the older adults remained low at 39.5 % in 2020. Although the per capita expenditure rose significantly, the disparities persisted, with lower spending for the 65+ age group (58.5 USD) compared to the children (64.6 USD) in 2020. Operative dentistry and endodontic treatment expenditures showed declines in spending share, while preventive care and periodontal treatment expenditures increased.
Conclusion: While Taiwan has made progress in increasing the dental utilization, especially for the children, challenges remain in improving access for the older adults. Policy adjustments

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are needed to enhance the dental care according to the diverse oral health needs of the different age groups.

Introduction

Dental care systems vary across different countries, with most offering coverage only for the children, adolescents, or basic services,[1] while the coverage for the adults and older adults is often more limited.[2] A researcher categorized the dental care models for the elderly in the developed countries into four types: deep coverage for the selected older adults (e.g., Canada, Australia), universal but shallow coverage (e.g., England, France), universal deep coverage (e.g., Germany), and limited coverage for the specific subgroups (e.g., United States).[3] Given that the dental needs differ by the age group, it is essential to allocate resources according to the demands of each age group for the effective service delivery.

Taiwan's National Health Insurance (NHI) system, implemented in 1995, covers over 99 % of the population, providing the comprehensive dental services such as the full-mouth scaling, restorations, root canal treatments, periodontal management, and tooth extractions, all at a minimal cost.[4] Japan also offers a comprehensive dental care through a universal health insurance system.[5] Thus, examining the dental service utilization patterns across the age groups in different countries with varying coverage models can provide the valuable insights into the resource allocation and service needs.

In addition to the overall dental service utilization, the types of dental services provided are equally important. In 1998, Taiwan's dental sector was the first within the NHI framework to adopt the global budget (GB) payment system. This system requires the dental care providers and NHI premium contributors to negotiate an annual expenditure cap for all covered dental services. The providers are responsible for managing costs while retaining the autonomy to determine which services are covered and how much each service is reimbursed.[6] Since the GB system's implementation, the providers have had increased incentives to collaborate with the health authorities to promote the preventive interventions. For instance, the fluoride mouth rinse has been provided in schools since 2000, the fluoride varnish services were introduced in 2006 and extended to kindergartens in 2012, and the molar pit and fissure sealant services were added in 2014.[7] Consequently, it is essential to examine whether the dental resources have been increasingly allocated to the preventive and non-invasive treatments by analyzing the expenditure patterns across different types of dental services.

A previous study showed that after the implementation of the GB system, the ionomer restorations and scaling procedures increased significantly, while the number of patient visits remained stable.[8] Since that study focused on the early stages of the GB system, it is crucial to examine the dental service expenditure trends two decades later. While some studies have analyzed NHI statistical reports on the dental caries,[9] periodontitis,[10] or pediatric services,[11] these reports offer only a fragmented view of the utilization patterns by the service type, year, or age group. They do not provide a comprehensive picture of the dental service utilization across the age and gender over an extended period.

Given the challenges posed by an aging population and growing demand for the oral healthcare, understanding the patterns of the dental service utilization across the age groups and gender over the past two decades is essential. Such insights are necessary to adapt the dental services to meet public needs and build a more comprehensive oral healthcare system. This study explored the trends in the Taiwan's dental services over the past 20 years and provided recommendations for the future dental services that align with population oral health needs.

Materials and methods

Study design

We aggregated the dental visit rate and fees of various dental service procedures for every NHI-covered dental care visit by the gender and age groups for the years 2000, 2005, 2010, 2015, and 2020 to analyze the trends in the dental care utilization and expenditure in Taiwan.

Data source

All health services provided by the contracted healthcare providers were electronically recorded and submitted to the NHI Administration (NHIA) for reimbursement. This database contained the details of each visit, including the procedure codes, service fees, provider characteristics, and demographic information of the NHI enrollees. The NHIA provided these data to the Health and Welfare Data Science Center (HWDC), where it was accessible for the research upon application. The HWDC was responsible for maintaining the data and anonymizing any identifiable individual information. This study was reviewed and approved by the Institutional Review Board of Sin-Lau Hospital (Study No. SLH-112-B-003). After receiving the approval, we accessed and analyzed the data on-site at the HWDC.

Study variables

Dependent variables

The main outcome variables were the dental visit rate (i.e., the percentage of NHI enrollees with at least one dental visit within a year), the average number of visits per dental

service user, and the per capita dental service expenditure. The dental visit rate was calculated by dividing the total number of individuals with at least one dental visit during the year by the total number of NHI enrollees throughout the year, rather than using the enrollee count at year's end. For the average number of visits per dental service user, we divided the total dental visits by the number of users who received the dental services.

The dental service expenditure was determined by multiplying the total medical points by the point value. In the NHI's GB payment system, the representatives from healthcare providers and premium contributors negotiated an annual expenditure cap, which acted as the numerator. The healthcare providers submitted the services in the form of medical points, based on a fee schedule, and the total sum of these points served as the denominator. The point value was calculated by dividing the expenditure cap by the total medical points. While the ideal point value was 1, in practice it typically fluctuated between 0.9 and 1.1. The point values for the NHI's dental global budget sectors were 1.01, 0.99, 0.98, 0.96, and 0.98 for the years 2000, 2005, 2010, 2015, and 2020, respectively.[12–15] The per capita dental service expenditure was reported in New Taiwan dollars (NTD), approximately equal to 0.033 United States dollars (USD) in 2020.

Independent variables

The independent variables included two demographic factors: (1) gender, categorized as male or female; and (2) age, divided into four age groups: under 15 years, 15—44 years, 45—64 years, and 65 years and older. Additionally, to analyze the expenditure trends across different types of dental services, we classified all dental treatment items and procedures into the following 11 fee categories.

1. Physician fee (PF): This category included all outpatient consultation fees, excluding the consultation fee for the first visit of the year.
2. Operative dentistry (OD): This category covered all items in the operative dentistry chapter of the NHI fee schedule, such as the restorative procedures like amalgam fillings, composite resin fillings, and glass ionomer restorations.
3. Endodontic treatment (ENDO): This category encompassed all items in the endodontic treatment chapter, including the root canal treatments, apicoectomies, and other related procedures.
4. Periodontal treatment (PERI): This category included all items in the periodontal treatment chapter, such as the subgingival scaling and the comprehensive periodontal treatment, but excluded the full-mouth and localized scaling.
5. Oral surgery (OS): This category included simple and complex tooth extractions as well as other medical procedures and surgeries performed by the dentists.
6. Prevention (PRV): This category included the preventive services such as the fluoride applications and pit and fissure sealants. Although these services were funded by the Ministry of Health and Welfare (MOHW) and were not covered under the NHI, they were still provided by the dentists, who claimed and received reimbursement through the NHIA. As a result, our study could track these services and included them in the calculation of the dental expenditure.
7. Preventive treatment (PVTX): This category included the full-mouth scaling, localized scaling, and fluoride treatments.
8. Physician fee and X-ray (PFXRAY): This category covered the consultation fees, annual X-ray exams, and panoramic X-ray exams for the enrollee's first visit of the year.
9. Anesthesia (ANTH): This category included the local anesthesia for the dental procedures.
10. Dental radiography (XRAY): This category included the bitewing radiography, periapical radiography, panoramic radiography, etc.
11. Other fee (OTH): This category encompassed all fees not covered by the categories above, including the additional charges for the programs designed to improve access to the dental services in the underserved areas and the pilot programs for the specialized dental services.

Data analysis

Statistical analyses were conducted using SAS 9.3.1 (SAS Institute, Cary, NC, USA). Because this was a descriptive study with the administrative data on all NHI enrollees, we did not conduct tests of inferential statistics or estimate the confidence intervals.

Results

Table 1 presents the data on the dental service utilization in Taiwan from 2000 to 2020, broken down by the gender and age groups. The dental visit rate showed a steady increase over time for both genders and all age groups. For example, the males demonstrated an increase from 32.0 % in 2000 to 45.3 % in 2020, while the females exhibited an increase from 37.0 % in 2000 to 50.3 % in 2020. Among the age groups, the 0—14 age group experienced the largest rise, jumping from 37.0 % in 2000 to 66.9 % in 2020, reflecting a greater access or emphasis on the dental care for the children.

The dental visits per user remained stable over the two decades, with both males and females averaging around 3.0—3.2 visits per year. The 65+ age group showed a slight increase, from 3.3 visits in 2000 to 3.6 visits in 2020, likely reflecting the growing dental care needs of the elderly.

The expenditure per capita also increased significantly across all demographics. The males revealed an expenditure rise from 1060 NTD in 2000 to 1825 NTD in 2020, and the females from 1315 NTD in 2000 to 2040 NTD in 2020. The most substantial growth occurred in the 65+ age group, where the per capita expenditure nearly doubled from 940 NTD in 2000 to 1756 NTD in 2020, indicating the higher costs or more intensive dental treatments for the older adults.

Fig. 1 showed that there were no significant differences in the proportion of the expenditure and per capita spending across the different types of dental services between the males and females. For both genders, the OD accounted for the highest proportion of the expenditure.

Table 1 The dental service utilization and expenditure in Taiwan from 2000 to 2020.

Utilization type/Demographics		2000	2005	2010	2015	2020
[a]Dental use rate						
Gender	Male	32.0%	36.9%	40.8%	44.4%	45.3%
	Female	37.0%	42.1%	45.9%	49.5%	50.3%
Age groups (year)	0–14	37.0%	45.8%	51.3%	62.3%	66.9%
	15–44	34.0%	38.2%	41.8%	44.8%	46.0%
	45–64	33.4%	38.3%	42.5%	44.2%	44.2%
	65+	28.7%	32.0%	35.8%	38.7%	39.5%
Total		34.0%	39.0%	42.8%	46.2%	47.0%
Visits per user						
Gender	Male	3.0	3.1	3.1	3.0	3.1
	Female	3.2	3.2	3.1	3.1	3.2
Age groups (year)	0–14	3.1	3.1	2.9	3.0	3.1
	15–44	3.0	3.0	2.9	2.8	2.8
	45–64	3.3	3.4	3.4	3.4	3.4
	65+	3.3	3.5	3.5	3.6	3.6
Total		3.1	3.1	3.1	3.1	3.1
[b]Expenditure per capita						
Gender	Male	1060	1235	1380	1523	1825
	Female	1315	1479	1595	1731	2040
Age groups (year)	0–14	1156	1429	1517	1671	1939
	15–44	1217	1338	1475	1571	1864
	45–64	1174	1375	1524	1673	1994
	65+	940	1065	1231	1429	1756
Total		1172	1336	1467	1596	1894

[a] Dental use rate is defined as the percentage of individuals who have at least one dental visit within a year.
[b] Dental service expenditure per capita is reported in New Taiwan dollar (NTD), with 1 NTD being approximately equal to 0.033 United States dollar (USD) in 2020.

However, this proportion gradually declined from over 40 % in 2000 to less than 30 % in 2020. Despite this decrease in proportion, the per capita expenditure on the OD did not drop over time, indicating that the decline in its share is mainly due to faster growth in spending on other dental services. A similar pattern was observed with the ENDO expenditure.

The categories with the fastest expenditure growth included the PF and PERI. PF showed consistent increases in both the spending and proportion over the years, while the PERI experienced a significant rise in the expenditure and share after the comprehensive periodontal care was fully incorporated into the reimbursement standards in 2010. Other services, such as the PVTX and OS, also showed a steady increase in the expenditure over time. However, because the overall per capita dental expenditure also increased, their proportions remained relatively stable at around 10 % over the two decades.

Fig. 2 illustrates notable trends in dental service utilization across different age groups. The OD declined across all age groups, with a sharp decrease in the 0–14 age group. This decline, coupled with a rise in PRV after 2010, reflects a stronger focus on preventive dental care. In the 15–44 age group, OD declined moderately, while a unique rise in OS was observed, setting this group apart from others. The ENDO showed a steady decline in share across all age groups, though per capita ENDO expenditure remained stable. The PERI increased significantly, particularly in the 45–65 and 65+ age groups after 2015.

Discussion

This study offered a detailed overview of the dental service utilization trends in Taiwan over the past two decades, examining the patterns by the gender, age groups, and types of dental services. The notable rise in the dental visit rates, particularly for the children (0–14) and the older adults (65+), reflected the impact on the Taiwan's NHI system, which provided an extensive and affordable dental care to over 99 % of the population, significantly enhancing the access across all demographics.

However, it was noteworthy that despite the USA did not have the universal and comprehensive dental coverage, its dental utilization rates were already high in the late 1990s. The 1996 Medical Expenditure Panel Survey reported a dental use rate of 43.19 %,[16] while the 1997 National Health Interview Survey indicated a rate of 65.1 %, a level that remained steady through 2010, when the overall percentage with a dental visit was approximately 64.7 %.[17] The dental use rates in the USA varied significantly by the age, with the highest rate (77.0 %) among those aged 2–20 and the lowest (61.8 %) among the adults aged 21–64. Similarly, Taiwan showed the age-related differences in the dental visit rates,

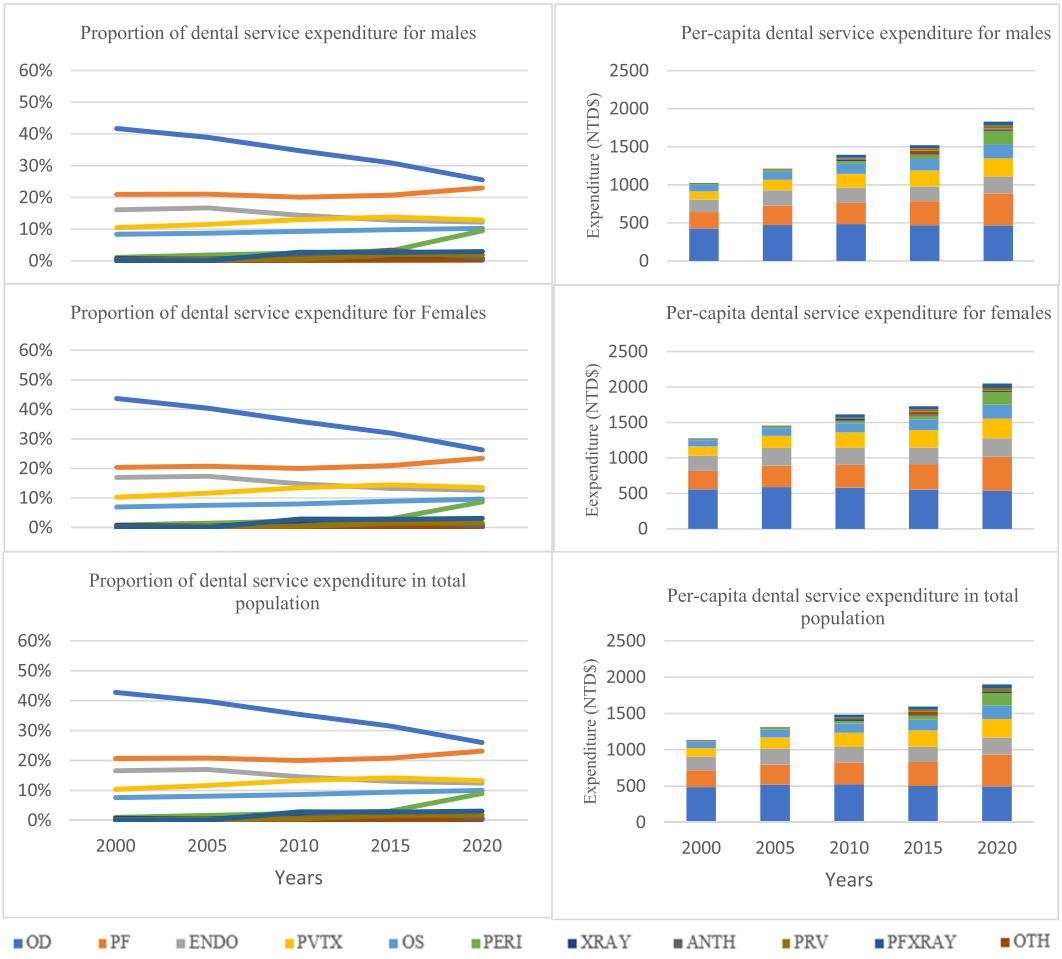

Figure 1 The trends in the proportion and the per-capita dental service expenditure by the gender in Taiwan from 2000 to 2020. Abbreviations: OD, operative dentistry; PF, physician fee; ENDO, endodontic treatment; PVTX, preventive treatment; OS, oral surgery; PERI, periodontal treatment; XRAY, dental radiography; ANTH, anesthesia; PRV, prevention; PFXRAY, physician fee and X-ray; OTH, other fees.

with the 0—14 age group having the highest rate (51.3 %) and the 65+ age group the lowest (35.8 %) in 2010, but both considerably lower than the USA rates for the same year.

The higher dental use rate among the USA adults aged 65 and older compared to those aged 21—64 is largely due to the Medicare coverage for the seniors. In contrast, the Taiwan's NHI provided the coverage for the entire population, resulting in the different patterns of the dental utilization across the age groups in two countries. It was important to note that the different survey methods in the USA could produce considerable variations in the reported dental use rates. This study used the nationwide NHI administrative claim data instead of the survey data, whereas the USA estimates included the visits to the dental hygienists,[18] who were not covered under the Taiwan's NHI. Therefore, caution should be exercised when making the international comparisons of the dental use rates, because the services and coverage varied significantly between the different countries.

Regarding the dental service expenditure, the Taiwan's NHI dental spending has steadily increased over the years. Even during the COVID-19 pandemic in 2020, when the dental visit rates dropped significantly,[19] the overall spending remained stable. This was largely due to the NHI's GB system, which ensured an annual dental budget cap. Thus, when the utilization dropped, the point value increased sharply, maintaining the expenditure on the dental services.[15]

The long-term trends in the dental spending by the age indicate that the per capita dental expenditure for the individuals aged 65 and older was lower than those of the other age groups. In 2020, the per capita expenditure for this group was about 58.5 USD, which was higher than Japan's 32.8 USD for the same age group.[5] Additionally, the Japan's per capita dental expenditure for the children under 15 was just 16.7 USD in 2020, compared to the 64.6 USD for the Taiwanese children of the same age, highlighting significant differences in the dental spending between the two countries.

It is important to note that the Japan's universal health insurance system covers the dental services such as the fillings, endodontic treatment, crowns, bridges, dentures, and tooth extractions, but does not include the preventive services. In contrast, the Taiwan's NHI officially did not cover the preventive services like the fluoride varnish and pit and fissure sealants; however, these were reimbursed through the NHIA and included in the calculation of the dental

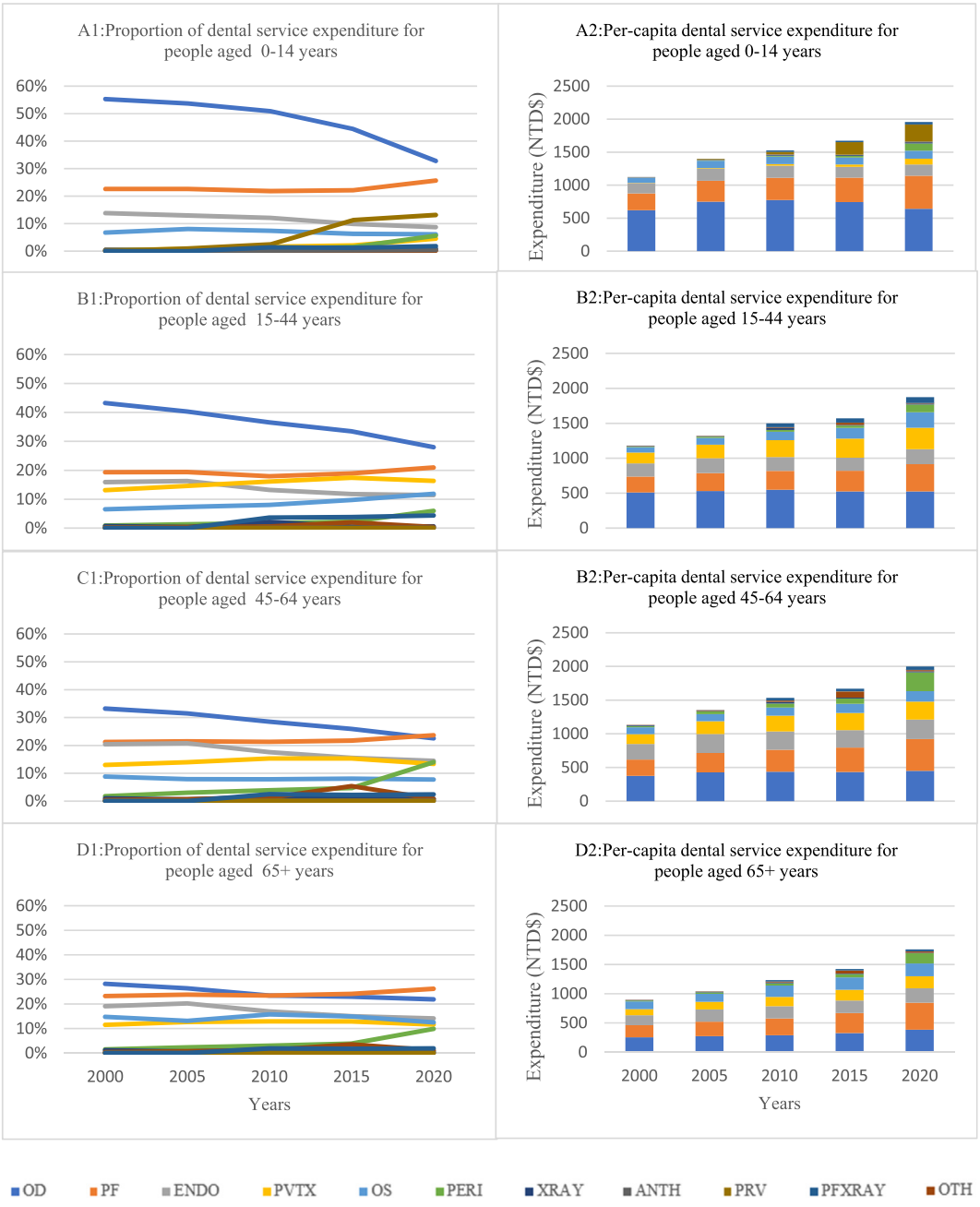

Figure 2 The trends in the proportion and the per-capita dental service expenditure by the age group in Taiwan from 2000 to 2020-12701492250. Abbreviations: OD, operative dentistry; PF, physician fee; ENDO, endodontic treatment; PVTX, preventive treatment; OS, oral surgery; PERI, periodontal treatment; XRAY, dental radiography; ANTH, anesthesia; PRV, prevention; PFXRAY, physician fee and X-ray; OTH, other fees.

expenditure. As a result, the basis for estimating the per capita dental expenditure for the children under 15 differed from that used in the Japanese studies. Setting aside the expenditure, the DMFT (decayed, missing, and filled teeth) index for the 12-year-old Taiwanese children improves from 2.50 in 2012 to 2.01 in 2020,[20] though there is still room for the progress. The Japan's DMFT index for the 12-year-olds dropped significantly from 4.6 in 1985 to 0.8 in 2016. Taiwan could benefit from studying the Japan's approach to further enhance the oral health of the children.[21]

The stability in the visits per user across the age and gender groups reflects the consistent utilization, but the rising per capita expenditure highlights the increasing complexity and the cost of dental treatments, particularly for the older adults. The almost doubled per capita expenditure for the 65+ group from 2000 to 2020 suggests that this demographic is experiencing greater dental health needs, possibly due to the higher rates of the periodontal disease and other age-related oral conditions. The GB payment system, which Taiwan adopted in 1998, has likely

supported this trend by incentivizing the cost control and the preventive services among the providers, while still allowing the flexibility to address evolving patient needs.

Our study also showed that the utilization patterns differed significantly by the age group, with a general decline in the OD services and a rise in the PRV, particularly among the younger age groups. This trend aligned with the NHI's growing focus on the preventive care, such as the fluoride varnish application for the pre-school children, the fluoride mouth-rinsing, the pit and fissure sealant for the permanent first molars, and the salt fluoridation.[22] These policies are consistent with the international recommendations for the early non-invasive interventions to reduce the dental caries and minimize the need for the subsequent invasive treatments. However, further analysis is needed to clarify the relationship between PRV use and reductions in OD treatments.

Additionally, the OS share showed an upward trend only in the 15—44 age group, likely related to increased demand for extractions for orthodontic treatment or third molar removal. Meanwhile, the significant increase in the PERI among older adults corresponds with policy changes, such as the introduction of the comprehensive periodontal care plan in 2010 and expanded NHI coverage for periodontal treatment. This shift suggests a growing responsiveness to the oral health needs of the Taiwan's aging population, who often require a more intensive care due to the chronic periodontal issues.

In conclusion, the Taiwan's NHI model demonstrates a successful example of a comprehensive dental care system that accommodates the demographic-specific demands, particularly in the context of an aging population. The findings suggest that other countries can benefit from implementing the similarly comprehensive dental care policies, especially as the global populations continue to age. Future researches can explore the long-term impacts of the preventive care policies on the overall dental health outcomes and investigate the cost-effectiveness of the resource allocation within the different dental service categories.

Declaration of competing interest

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

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