

Original Article

The impact of the global budget system on dynamics of dental manpower and utilization of dental services

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ABSTRACT

Background: This study aimed to investigate dentists' supply and practice patterns following the implementation of the global budget system in Taiwan.

Materials and Methods: Data of reimbursement claims, municipal socioeconomic status and dental manpower were collected from the National Health Insurance administration, the Ministry of Internal Affairs, and the Ministry of Health and Welfare, respectively. A multivariate linear regression method was used for data analysis.

Results: A municipality that reported a higher percentage of tertiary educated population ($t = 3.718$, $P < 0.001$), a higher per capita income ($t = 6.172$, $P < 0.001$), a higher population density ($t = 6.172$, $P < 0.001$), or a lower percentage of elderly population ($t = -2.506$, $P = 0.014$) was more likely to have a higher number of dentists per 100,000 population. A municipality that reported a higher Herfindahl-Hirschman Index (HHI) value ($t = 2.880$, $P = 0.005$) was more likely to show a higher move-out rate among dentists. The rate was lower after the implementation of the global budget system ($t = -2.436$, $P = 0.018$). A municipality that had a higher percentage of elderly population ($t = 3.628$, $P < 0.001$), a lower percentage of young population ($t = -2.138$, $P = 0.035$), or a higher rate of population growth ($t = 4.412$, $P < 0.001$) was more likely to display a higher move-in rate among dentists. The percentage of amalgam restorations in total claims reduced from 19.82% to 17.94%, while the percentage of tooth-colored material restorations increased from 25.46% to 28.79%.

Conclusion: This study has demonstrated a stabilizing effect of the global budget system on dynamics of dental manpower in Taiwan. A relationship between HHI and dentists' move-out rate has been found. The relationship between municipal socioeconomic status and the density of dentists has also been confirmed. In addition, reduced utilization of amalgam restorations was accompanied by increased utilization of tooth-colored material restorations. Further investigations are indicated.

Key Words: Amalgam, composite resins, dentist, global, budget, health insurance, Herfindahl-Hirschman Index

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INTRODUCTION

The term of the "global budget system" started to appear in medical literature since 50 years ago.^[1] The global budget system indicates a payment method

"by which hospitals are allotted a specific amount of money and are then free to distribute the funds according to their individual priorities."^[2] Although

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initial purposes of the system were to provide hospitals and clinics a “greater flexibility in the distribution of funds received” and “a financial incentive to operate as efficiently as possible.”^[2] cost reduction to health care services by “putting hospitals at operating risk” has become an expected effect.^[3] By year 2014, this payment system has been implemented on different scopes of health care services in countries such as Canada,^[2] Germany,^[4] Switzerland,^[3] the United States of America (USA),^[5] and Taiwan.^[6] To the best of our knowledge, the earliest inclusion of dental services in the global budget system commenced in Germany^[4] and was followed by Taiwan.^[6]

The global budget system applied to Dental Care Services in Taiwan was planned and Monitored by the Ministry of Health and Welfare (MOHW). To implement the system, a budget was allocated to the six regional branches of the National Health Insurance (NHI) administration, including Taipei Region, Northern Taiwan, Middle Taiwan, Southern Taiwan, Kaohsiung-Pingtung Region, and Eastern Taiwan.^[6] An expenditure cap was decided according to the expenditure of dental services in the previous year. Although a limited annual increase of the expenditure was included in the cap, the reimbursement value of each item would become lower when the amount of dental services used was larger than a previously planned target.^[6]

The expected outcomes of the global budget system in Taiwan included an increase in the quantity of preventive dental care and a well-controlled expenditure cap under peer pressure within dental associations. The government has been satisfied with the effect of the global budget system and expanded the implementation to the scope of traditional Chinese medicine and modern medicine years later.^[7] However, dental practitioners were concerned with payment inequity in relation to market competition and disparities of socioeconomic status.

Health care provider supply and competition in the health care market have a reciprocal influence for each other.^[8] Dentist over-supply is becoming an issue of concern in developed countries such as Canada,^[9] Sweden,^[10] United Kingdom^[11] and the USA,^[12] as well as newly industrialized countries including South Africa^[13] and India.^[14] To boost the work capacity of over-supplied dental manpower, some researchers suggested that the government should offer dental insurance to induce demand for dental services.^[15]

A previous study reported that new dental graduates did not follow traditional models of dentist distribution when entering a service market.^[16] Indeed, there was no relationship between young dentists’ selection of practice location and the population size of an area.^[16] The density of dentists in an area was enhanced by factors such as the opportunity of dental training programs, residents’ per capita income, health care expenditures per resident, the proportion of minority in the community, and the insurance penetration rate.^[16]

The situation in Taiwan was different 50 years ago when Baker and Perlman reported a low reputation, mild income, and insufficient manpower of dental practices.^[17] At that time, a low registration rate at dental schools in Taiwan was also identified.^[17] In the early 70’s, only three-quarters of dental graduates practiced in private clinics, and 12.1% of them left Taiwan for purposes such as advanced studies or immigration.^[18] Dynamics of the dental manpower in Taiwan depended on the size of the community population although the density was as low as 6.6 dentists per 100,000 population then.^[18] This was different from young American dentists’ relocation that was motivated by a variety of factors.^[18] An uneven distribution of dentists in Taiwan has been reported, and approximately 30% of Taiwanese towns have never attracted a qualified dentist before 1990.^[19,20] By the end of the 20th century, the highest and lowest density of dentists was reported in Taipei City (67.5 dentists/100,000 population) and Penghu County (5.2 dentists/100,000 population), respectively.^[19,20] Compared to the Capital of the USA which had almost 100 dentists/100,000 population at a similar survey time,^[21] the Capital of Taiwan, Taipei City, was not severely overwhelmed by over-supply of dental manpower, not to mention rural and remote areas such as Penghu County.

When searching the MEDLINE literature database with a combination of keywords including “dentist,” “dental practice,” “dental surgeon” or “dental manpower” and “global budget,” only four papers were identified.^[22-25] Excluding a paper reporting pharmaceutical expenditures but not utilization of dental care services,^[22] the remaining studies reported controversial outcomes.^[23-25] Hsueh *et al.* suggested that the implementation of the global budget system failed to improve the distribution of dental manpower because of a declined utilization of dental care services.^[23] On the contrary, two studies demonstrated

an increase in utilization following a more intense competition of dental care market resulting from the implementation of the global budget system.^[24,25] Although the NHI system in Taiwan has established an international reputation for its effectiveness,^[26] dynamics of dental manpower in relation to the global budget system remained under-investigated. Therefore, this study aimed to investigate into dentists supply and practice patterns and to assess structural changes of dental manpower following the implementation of the Global Budget System in Taiwan. An additional interest of this study was to report utilization of dental care services in relation to the application of the payment scheme. The hypothesis of the study was that the distribution of dental manpower was influenced by socioeconomic factors and the implementation of the global budget system.

MATERIALS AND METHODS

This study compared the difference in dental practice patterns with pre- and post-innovation of the Global Budget System in Taiwan. Cross-sectional data were applied to assess distribution of dental manpower among practice locations and longitudinal data were used to analyze transition of practice patterns.

Because nationwide health care data were unattainable, claim data from the Bureau of National Health Insurance (BNHI) from 1995 to 1998 were used. The data used included frequency of dental visits, diagnoses, treatments and the total fee charged. Socioeconomic data collected from the annual report of the Ministry of Internal Affairs (MOI), including levels of education, family revenue and health expenditures, were divided into six regions according to regional branches of the BNHI. Demographic data received from the MOI were composed of the density and growth rate of the population, as well as the percentages of elderly and young populations. The elderly and young populations were defined as those residents who were 65-years-or older, and those children who were 14-years-or younger, respectively. Dental manpower data such as registrations for practice locations were received from the MOHW.

To take the effect of market competition on dental manpower into account, the Herfindahl-Hirschman Index (HHI) was applied as estimate the level of competition within a domestic dental market. HHI was previously developed to assess market concentration in the discipline of economics.^[27] It was formulated as:

$$HHI = \sum_{i=1}^x n_i^2 = \sum (n_i/N)^2, i = 1, 2, \dots, x$$

Where x was the number of dental hospitals/clinics located in a municipality (a city or county), n_i was the number of dentists registered at a hospital/clinic of the municipality, and N was the total number of dentists registered in a municipality.

The value of HHI is located in a range between 0 and 1. An HHI value closer to 1 indicates a market closer to a monopoly, while an HHI approaching to 0 represents a highly competitive market.^[27] A dentist move-in rate was defined as the quotient having the move-in number divided by the total number of dentists in a municipality. Similarly, a dentist move-out rate was calculated with the same division methods.

Data entry and statistical analysis were carried out with IBM SPSS Statistics (version 19.0, IBM Corporation, Somers, NY, USA). Data analysis included descriptive statistics. A multivariate linear regression method with a step-wise approach was used to assess the individual contribution of socioeconomic and demographic factors in relation to dependent variables of dental manpower. The dependent variables included the number of dentists per 100,000 population, dentists' move-out rate and dentists' move-in rate.^[28] Dental claims from July 1997 to December 1998 were analyzed as the global budget system has been implemented in Taiwan since July 1998.^[22-25] Eight categories of treatment carried out as outpatient dental care services and reimbursed under the global budget system were included in the study. These included radiographic examinations, endodontic treatments, amalgam restorations, tooth-colored restorations (composite resin and/or glass ionomer cement restorations), periodontal surgeries, nonsurgical periodontal treatments, oral and maxillofacial surgeries, and pulpotomies for deciduous teeth. Utilization of dental services in each treatment category before and after the implementation of the global budget system was examined with a Chi-square method.^[28] The two-sided significance level for all statistical procedures was set at 5%.

RESULTS

During the 4 year study, the average number of dentists in a municipality of Taiwan ranged from 9.6 to 70.5 dentists/100,000 population. Taipei City and Chiayi County (an agricultural county located in Southern Taiwan) reported the highest and lowest

density of dentists, respectively. The difference in the density between Taipei City and Chiayi County reduced from 8.4 times in 1995 to 6.7 times in 1998. On the other hand, dentists' move-out rate ranged from 0.024 to 0.130. The highest move-out rate was seen in Penghu County, while the lowest was identified in Tainan County, which was another agricultural county located in Southern Taiwan. The move-in rate among dentists ranged from 0.084 to 0.170, with the lowest and highest value in Taipei City and Penghu County, respectively. Of further note, the range of the HHI calculated was from 0.002 to 0.117. Taipei County (a metropolis surrounding Taipei City; with the name changed to New Taipei City in Year 2010) and Penghu County had the lowest and highest values of HHI, respectively.

A municipality that reported a higher percentage of tertiary educated population ($t = 3.718, P < 0.001$), that had a higher per capita income ($t = 6.172, P < 0.001$), that showed a higher population density ($t = 6.172, P < 0.001$), that displayed a lower percentage of elderly population ($t = -2.506, P = 0.014$), or that was located at middle Taiwan ($t = 4.234, P < 0.001$) was more likely to have a higher number of dentists per 100,000 population [Table 1]. Implementation of the global budget system, per capita health care expenditure, the percentage of young population, the HHI value, geographic locations other than middle Taiwan, and the years were not related to the density of dentists ($P \geq 0.097$).

In addition, a municipality that reported a higher HHI value ($t = 2.880, P = 0.005$) was more likely to show a higher move-out rate among dentists [Table 2]. The rate was lower after the implementation of the global budget system ($t = -2.436, P = 0.018$) and in Southern Taiwan ($t = -2.949, P = 0.004$). Other factors were not associated with dentists' move-out rate ($P \geq 0.258$).

Moreover, a municipality that had a higher percentage of elderly population ($t = 3.628, P < 0.001$), that reported a lower percentage of young population ($t = -2.138, P = 0.035$), or that showed a higher rate of population growth ($t = 4.412, P < 0.001$) was more likely to display a higher move-in rate among dentists [Table 3]. Year 1996 also showed a higher move-in rate compared to year 1995 ($t = 3.385, P = 0.001$). None of other factors was in connection with the rate ($P \geq 0.243$).

On the other hand, the number of dental management items claimed to the NHI in the years 1997 and

Table 1: Individual contribution of socioeconomic and demographic factors to dentists' number per 100,000 population

Independent variables ¹	β	t	P
Postglobal-budget/preglobal-budget	0.048	1.081	0.283
Northern Taiwan/Taipei	-0.083	-1.676	0.097
Middle Taiwan/Taipei	0.108	4.234	<0.001*
Southern Taiwan/Taipei	0.022	0.466	0.642
Kaohsiung-Pingtung/Taipei	-0.028	-0.608	0.545
Eastern Taiwan/Taipei	0.071	1.652	0.102
1996/1995	0.007	0.164	0.870
1997/1995	-0.029	-0.678	0.500
1998/1995	-0.044	-0.990	0.325
Percentage of tertiary educated population	0.018	3.718	<0.001*
Per capita income	2.913E-07	6.172	<0.001*
Per capita health care expenditure	0.011	0.232	0.817
Percentage of elderly population (≥ 65 years old)	-0.143	-2.506	0.014*
Percentage of young population (≤ 14 years old)	0.031	0.573	0.568
Population density	4.127E-05	6.172	<0.001*
Herfindahl-Hirschman Index	0.053	0.573	0.568

* $P < 0.05$; ¹Adjusted $R^2 = 0.842$

Table 2: Individual contribution of socioeconomic and demographic factors to dentists' move-out rate

Independent variables ¹	β	t	P
Postglobal-budget/preglobal-budget	-0.115	-2.436	0.018*
Northern Taiwan/Taipei	-0.037	-0.338	0.736
Middle Taiwan/Taipei	0.034	0.307	0.760
Southern Taiwan/Taipei	-0.166	-2.949	0.004*
Kaohsiung-Pingtung/Taipei	0.039	0.343	0.732
Eastern Taiwan/Taipei	-0.079	-0.709	0.481
1996/1995	0.038	0.333	0.740
1997/1995	0.087	0.761	0.449
1998/1995	0.151	1.141	0.258
Percentage of tertiary educated population	-0.018	-0.157	0.876
Per capita income	-0.066	-0.479	0.633
Per capita health care expenditure	0.093	0.856	0.395
Percentage of elderly population (≥ 65 year-old)	-0.094	-0.569	0.572
Percentage of young population (≤ 14 year-old)	-0.009	-0.065	0.949
Population density	0.066	0.596	0.553
Population growth rate	0.053	0.433	0.667
Herfindahl-Hirschman Index	2.874	2.880	0.005*

* $P < 0.05$; ¹Adjusted $R^2 = 0.257$

1998 was 11,190,099 and 11,310,202, respectively [Table 4]. The growth rate of items claimed was 1.07%. The percentage of amalgam restorations reduced from 19.82% in the year 1997 to 17.94% in the year 1998, while the percentage of tooth-colored material restorations, increased from 25.46% to 28.79%. Other categories of dental management items showed a negligible range of changes in the percentages of claims. Figures 1 and 2 show

a decreasing trend in the percentage of amalgam restorations among total claims, in relation to an increasing trend in tooth-colored material restorations. All other management items displayed a negligible range of changes according to the monthly data.

DISCUSSION

This is the first study to suggest a stabilizing effect of the global budget system on dynamics of dental manpower. Dentists' move-out rate was lower after the implementation of the payment system. However, this study did not find a relationship between the global budget system and the number of dentists per 100,000

population as well as dentists' move-in rate. Thus, a lower move-out rate reported by this study indicated that the implementation of the payment system contributed to a more stable market.^[29] This resembled a previous study demonstrating that distribution of dentists was not improved by application of the global budget system.^[23] As the NHI reimbursement paid to each geographic region was "restricted by the predetermined expenditure cap," any increase in the service capacity would result in a lower reimbursement value for all items claimed by dentists in a region.^[23] Thus, local dental associations could have raised the threshold for entry, such as a high registration fee, to deter new dentists from moving into the market. This would consequently prevent existing dentists from moving out of a region since the cost of moving into another region could be too high. Nevertheless, new dental graduates could only move in but not move out a market. This might explain the reason why only the move-out rate was reduced following the implementation of the global budget system.

This study has also reported for the 1st time a positive relationship between HHI and dentists' move-out rate. According to literature, a higher HHI value indicated a

Table 3: Individual contribution of socioeconomic and demographic factors to dentists' move-in rate

Independent variables [†]	β	<i>t</i>	<i>P</i>
Postglobal-budget/preglobal-budget	0.017	0.162	0.872
Northern Taiwan/Taipei	-0.100	-0.807	0.422
Middle Taiwan/Taipei	0.068	0.683	0.496
Southern Taiwan/Taipei	-0.028	-0.299	0.766
Kaohsiung-Pingtung/Taipei	0.103	1.047	0.298
Eastern Taiwan/Taipei	0.067	0.699	0.486
1996/1995	0.035	3.385	0.001*
1997/1995	0.041	0.429	0.669
1998/1995	0.030	0.319	0.750
Percentage of tertiary educated population	-0.121	-1.175	0.243
Per capita income	-0.041	-0.329	0.743
Per capita health care expenditure	-0.051	-0.551	0.583
Percentage of elderly population (≥ 65 years old)	0.013	3.628	<0.001*
Percentage of young population (≤ 14 years old)	-7.67E03	-2.138	0.035*
Population density	-0.183	-1.660	0.100
Population growth rate	2.854	4.412	<0.001*
Herfindahl-Hirschman Index	0.086	0.673	0.503

**P*<0.05, [†]Adjusted *R*²=0.256

Table 4: Percentages of utilisation of dental services

Categories of treatment items	1997 (<i>n</i> =11,190,099)%	1998 (<i>n</i> =11,310,202)%
Radiographic examination	0.20	0.24
Endodontic treatment	13.50	13.19
Amalgam restoration	19.82	17.94
Tooth-colored material restoration	25.46	28.79
Periodontal surgery	3.37	3.24
Non-surgical periodontal treatment	17.06	17.25
Pulpotomy	0.54	0.58
Oral and maxillo-facial surgery	16.14	16.30
Other management items	3.91	2.47
Total	100	100

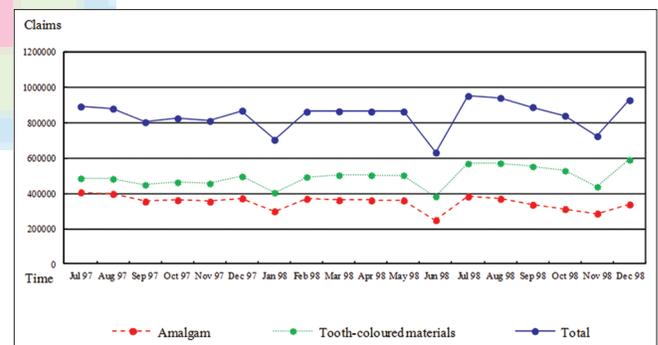


Figure 1: Number of amalgam and tooth-colored material restorations claimed to national health insurance.

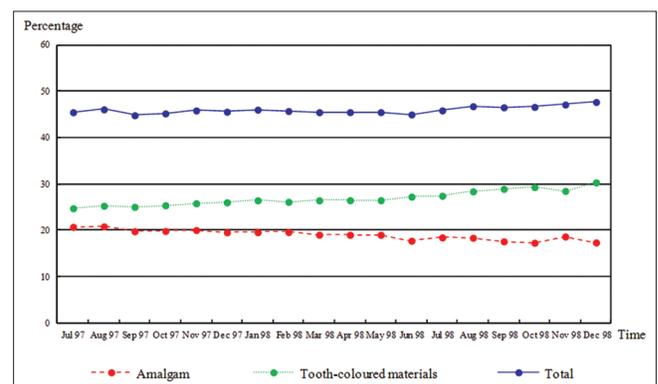


Figure 2: Percentage of amalgam and tooth-colored material restorations claimed to national health insurance.

market closer to a monopoly.^[27] Because data of HHI and dentists' move out rate were collected from the corresponding years, it became difficult to interpret a causal relationship between these two variables. A possibility was that a higher move-out rate reduced the number of dentists in a municipality and consequently led the market toward a status of a monopoly. On the other hand, a monopoly-like market could indicate a municipality that had fewer dentists. These municipalities were generally agricultural or island countries characterized by a smaller population size and lower per capita income. Furthermore, an earlier study reported that a higher HHI value contributed to a lower amount of dental care expenditure per person.^[24] Thus, dentists could have opted to move out from a high HHI municipality due to a less profitable practicing location and the less preferred living environment. Since both situations could result in a positive relationship between HHI and dentists' move-out rate, further investigations are indicated.

In addition, this study demonstrated a positive relationship between the density of dentists and average socioeconomic status of a municipality. We found that a higher number of dentists per 100,000 population was accompanied by a higher percentage of the tertiary educated population and a higher per capita income of a municipality. This agreed with an earlier study reporting that more dentists opted to practice in areas of high socioeconomic status.^[30] Relevant reasons for the concentration of dentists in high socioeconomic areas included children's education, family reasons, financial reasons, and professional development.^[31] As a higher number of dentists with more years' experience opted to practice in wealthier areas,^[30] new dental graduates could have consequently moved into low socioeconomic areas such as municipalities showing a higher percentage of the elderly population. This was also confirmed by our study, since a lower density of dentists and a higher move-in rate among dentists were seen in municipalities with a higher percentage of the elderly population. Even though young dental graduates showed a higher likelihood to practice dentistry in disadvantaged areas compared to experienced dentists,^[30] years later they may still leave these areas for municipalities with a higher average socioeconomic status. This is becoming an important issue in health service planning. Although the implementation of the global budget system had a stabilizing effect on dynamics of dental manpower,

establishment of professional development programs and an attractive reimbursement value at underserved areas are indicated.

On the other hand, this study has identified a complementary relationship between amalgam and tooth-colored material restorations in the aspect of utilization of dental services. An upward trend of utilization of tooth-colored material restorations was accompanied by a downward trend of claims of amalgam restorations. This connection could have resulted from a higher reimbursement value of composite resin over amalgam restorations.^[32] Nevertheless, the influence from the implementation of the global budget system was unclear, as the complementary effect has been seen since a year prior to the commencement of the payment system. Of further note, a previous study has reported a transition of dental materials used from amalgam toward tooth-colored materials due to patients' esthetic considerations.^[33] Despite the fact that health risks from dental amalgam restorations remained controversial,^[34,35] amalgam has been permanently replaced by other materials for restorative dentistry in countries such as Sweden and Norway.^[36] Thus, the international trend could also have contributed to the complementary relationship between amalgam and tooth-colored materials in Taiwan.

CONCLUSION

This study has demonstrated a stabilizing effect of the global budget system on dynamics of dental manpower in Taiwan. A positive relationship between HHI and dentists' move-out rate has been reported by this study. The relationship between the socioeconomic status of a municipality and the density of dentists has also been confirmed. In addition, reduced utilization of amalgam restorations was accompanied by increased utilization of tooth-colored material restorations. Further investigations are indicated.

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Conflicts of interest

The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial or non-financial in this article.

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