Community Dent Oral Epidemiol 2007; 35: 459–464

COMMUNITY DENTISTRY AND ORAL EPIDEMIOLOGY

Influences of market competition on dental care utilization under the global budget payment system

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Tsai W-C, Kung P-T, Chang W-C. Influences of market competition on dental care utilization under the global budget payment system. Community Dent Oral Epidemiol 2007; 35: 459–464. © 2007 The Authors. Journal compilation © 2007 Blackwell Munksgaard

Abstract – *Objectives:* The degrees of market competition usually influence providers' behaviors. This study investigated the influence of medical market competition on the utilization of dental care under the global budget payment system. This study also examined the relative factors that influence the utilization of dental care. *Methods:* This study used the healthcare sub-regions (HCSRs) in the healthcare net as the observation units. The dataset was the National Health Insurance dental care claim data from 1999 to 2002. The degree of market competition of dental care was measured by the Herfindahl Index (HI). The influences of medical market competition on the utilization of dental care were analyzed by multiple linear regression analysis. *Results:* When the market had a higher degree of competition, people had a higher number of dental utilizations after controlling for the other variables. When market competition increased by 1%, annual expenditures and frequencies of dental care as well as frequencies of tooth-filling per person increased by 0.4%. Thirty-three percent of dental expenditures could be explained by increases in the degree of market competition. Females or highly educated people had a positive correlation with dental utilization. However, the agricultural population negatively correlated with dental utilization. Average household income had no significant relationship with the frequency of dental care but had a significant negative association with dental expenditures when dental care was covered by health insurance. *Conclusions:* After the global budget payment system for dental care was implemented, increases in dental care market competition led to the increase in utilization of dental care services.

Key words: dental utilization; global budget payment system; Herfindahl Index; market competition

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Submitted 23 November 2005;
accepted 12 July 2006

After the implementation of the National Health Insurance (NHI) program in 1995, the NHI provides universal and comprehensive health insurance with low co-payments for dental care. Dental care insurance has 100% coverage excluding non-health problem procedures such as orthodontics but including scaling. Dental care expenditures total about 11% of all healthcare expenditures in Taiwan, and have been escalating annually; the average annual growth rate of dental care spending from 1998 to 2002 was about 5.7% (1). In order to curtail the expenses incurred by the NHI system and to balance the medical resources, the capped global budget payment system for dental care was implemented in July 1998. The annual budget for dental care was carefully set to control the expenditures of dental care. But the dental global budget payment is still a fee-for-service system.

Previous studies (2–4) have given several reasons to explain the rise in healthcare expenses, such as the expansion of insurance coverage, the aging of

doi: 10.1111/j.1600-0528.2006.00355.x

the population, the expansion of healthcare manpower, the utilization of high-tech medical devices, advanced and expensive medical treatments, severity of illness, the varieties of chronic diseases, the increase in highly educated population, the increase in income, and the increase in medical care expenditure. Some studies (2, 5) have pointed out that, after controlling for confounding factors such as the agricultural population, aged population, and insured population, when healthcare resources increase, the healthcare utilization increases. We believe that dental care utilization might have similar associated factors. After the implementation of NHI in 1995, increases in the number of dentists accompanied the increase in dental expenditures (6). However, the results of some studies are not consistent with this finding (5, 7, 8). Previous studies (9–13) have shown that the change in market competition would affect the behaviors of suppliers and consumers. When market competition increases, healthcare expenditures and service volumes also increase (9–13).

Since 1998, the number of dentists has increased 16.5% until 2002, which reached 4.09 dentists per 10 000 population in Taiwan (1). Because the growth of dentists in an area will increase market competition, dentists' practice behaviors might focus on increase in service volumes. This study hypothesized that higher market competition would lead to higher dental care utilization. Very few studies examined the impact of market competition, under the capped global budget system, on dentists' practice behaviors and dental care utilization. Therefore, the purpose of this study was to investigate the influences of market competition on the utilization of dental outpatient visits and the factors associated with dental care expenditures under the capped global budget system in Taiwan.

Methods

Samples studied and data sources

This study used Taiwan's NHI nationwide medical claim data, which comprised the healthcare services for all insured patients or 97% of Taiwan's population (approximately 23 million people), for the years 1999 to 2002, to examine the impact of market competition on dental utilization. This study used the Health Care sub-Regions (HCSRs) in the healthcare net as the observation units. The HCSRs are the residential areas mapped out by the Department of Health in which the healthcare needs of residents can be conveniently met. This national healthcare net consists of 63 HCSRs, each HCSR containing five or six townships in Taiwan. There were a total of 252 HCSRs (i.e. 63 HCSRs × 4 years) in the years 1999 to 2002. The analyzed data were secondary data and the data sources were as follows: (a) Data on dental utilization of the insured were obtained from the NHI medical claim dataset from 1999 to 2002 published by the National Health Research Institute (NHRI). (b) Demographic data were obtained from the Taiwan Demographic Fact Book published by the Ministry of the Interior. (c) Data on annual household income were obtained from the Household Income and Expenditure Report published by the Department of Auditing.

Statistical analysis

In this study, data were analyzed by descriptive statistics, trend analysis and multiple linear regression analysis. In analysis models, dependent variables were the average dental outpatient visits per person per year, average dental care expenditures per person per year, and frequencies of tooth-filling per person per year. The degree of market competition was represented by the Herfindahl Index (HI). We calculated the market share to form the HI value. The HI indicated the concentration of the dental care market:

$$\mathrm{HI} = \sum_{\mathrm{i}=1}^{\mathrm{n}} \alpha_{\mathrm{i}}^{2}$$

In the formula, α represents one (the ith) dentist's market share in an HCSR which is the ratio of the dental service volume (i.e. number of visits) claimed by the ith dentist to total dental service volume claimed in an HCSR; n is the number of dentists in an HCSR. The value of HI is between 0 and 1. An HI value of 1 means that one dentist has 100% of the market share and reflects no market competition. The lower the value of HI, the higher is the competition in the dental care market. There are 63 HCSRs (also means 63 HI values) in this study per year. The relative factors were the control variables including proportion of age groups, proportion of females, average household income, highly educated population (i.e. with a college degree), and agricultural population. The multiple linear regression model in this study was as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \cdots + \varepsilon$$

In the formula, Y is the annual average frequencies per person and average expenditure of dental utilization per person and frequencies of tooth-filling per person; X_i is the degree of market competition (i.e. HI), proportion of females, proportion of age groups, highly educated population, agricultural population, and average household income; β is the regression coefficient; ε indicates the error term.

With respect to the accuracy of the regression model, in addition to examining the normal distribution of the variables, multicollinearity was also taken into consideration. When the value of variance inflation factor (VIF) was high (≥10), it indicated that a high multicollinearity existed between variables. Finally, a residual analysis was employed to examine whether the model meet the regression assumption in this study.

Results

Descriptive analysis

As for the utilization of dental care (Table 1), the HI from 1999 to 2002 was between 0.062 and 0.073; the average HI was 0.065 and its annual growth rate was −2.55%, which reflected that market competition of dental care escalated annually although the trend of increase in average market competition was not statistically significant ($P > 0.05$). The annual dental care expenditures and frequencies of dental care for each person escalated annually. The annual dental expenditures for each person significantly increased from 985 NT dollars in 1999 to 1147 NT dollars in 2002 ($P < 0.05$) and its annual growth rate was 5.19%. The average annual frequency of dental care per person in 1999 was 0.95 compared with 1.02 in 2002, an annual growth rate of 2.33% during these 4 years. From 1999 to 2002, the NHI reported a small annual growth rate (1.60%) in the frequency of tooth-filling per person.

Table 1. Annual growth rate of market competition and dental care utilization in HCSRs, 1999–2002

Variables	1999 Mean	2000 Mean	2001 Mean	2002 Mean	Annual growth rate (%)	Trend analysis – *P*-value
Market competition (HI)	0.067 (0.088)	0.073 (0.137)	0.058 (0.076)	0.062 (0.096)	−2.55	0.868
Average expenditures of dental care[a]	985 (2388)	1068 (2468)	1127 (2602)	1147 (2757)	5.19	0.001
Average frequency of dental care	0.95 (1.83)	0.97 (1.75)	1.00 (1.81)	1.02 (1.80)	2.33	0.124
Average frequency of tooth-filling	0.41 (0.08)	0.42 (0.09)	0.44 (0.09)	0.43 (0.08)	1.60	0.403
Female						
Expenditure	1112 (2535)	1196 (2607)	1260 (2733)	1278 (2730)	4.74	0.034
Frequency	1.06 (1.94)	1.07 (1.84)	1.10 (1.89)	1.12 (1.88)	1.85	0.016
Male						
Expenditure	866 (2232)	942 (2322)	1002 (2453)	1015 (2775)	5.43	0.038
Frequency	0.85 (1.72)	0.86 (1.65)	0.90 (1.71)	0.91 (1.70)	2.29	0.067
Age 0–4 years						
Expenditure	360 (1546)	444 (1732)	450 (1815)	510 (1949)	12.27	0.045
Frequency	0.37 (1.16)	0.41 (1.19)	0.39 (1.24)	0.38 (1.31)	0.89	0.924
Age 5–9 years						
Expenditure	1721 (2652)	1882 (2790)	2030 (2919)	2061 (2912)	6.20	0.033
Frequency	1.94 (2.36)	1.98 (2.31)	2.08 (2.37)	2.09 (2.34)	2.51	0.042
Age 10–14 years						
Expenditure	1019 (2202)	1067 (2242)	1087 (2255)	1029 (2136)	0.35	0.789
Frequency	0.99 (1.59)	0.98 (1.50)	1.00 (1.48)	0.97 (1.40)	−0.68	0.600
Age 15–24 years						
Expenditure	1166 (2696)	1267 (2782)	1371 (2949)	1404 (2950)	6.40	0.021
Frequency	0.99 (1.83)	0.99 (1.74)	1.01 (1.82)	1.00 (1.81)	0.34	0.326
Age 25–64 years						
Expenditure	998 (2410)	1062 (2471)	1109 (2597)	1113 (2875)	3.72	0.054
Frequency	0.96 (1.85)	0.98 (1.75)	1.03 (1.79)	1.05 (1.78)	3.03	0.017
Age 65 years and above						
Expenditure	783 (2172)	789 (2172)	790 (2235)	772 (2200)	−0.46	0.520
Frequency	0.86 (1.92)	0.86 (1.76)	0.91 (1.78)	0.95 (1.75)	3.37	0.052

[a]NT dollar (1 US dollar = 32 NT dollar).
HI, Herfindahl Index.
Values in parentheses are standard deviation.

In 1999, the frequency of tooth-filling per person was 0.41 compared with 0.43 in 2002.

Female subjects had higher dental care expenditure and number of visits than male subjects, whereas male subjects had higher annual growth rate than female subjects during this study period. Female subjects, on average, had approximately 26% of dental utilization more than male subjects (Table 1). Among six age groups, we found that patients aged 0–4 years and those aged ≥65 years tended to have lower dental care utilization, and those aged 5–9 years had the highest dental care spending and number of dental visits during 1999–2002, which was followed by the 15- to 24-year group. Our findings are consistent with those of a previous study (14).

Results of multiple regression analysis

Table 2 shows that all independent variables to expenditures of dental care could explain 58% of total variations of dental care expenditures. In light of the factors affecting expenditures of dental care, except for the population's age groups, all other variables were statistically significant ($P < 0.05$). After controlling for the other variables, when market competition increased 1% (i.e. coefficient decreased 1%), the annual dental care expenditure per person increased by 3.97 NT dollars (i.e. 0.4% of dental expenditure per person). Although 3.97 NT dollars per person is small it reflects an increase of approximately 100 million NT dollars for dental care a year due to market competition in Taiwan, which is quite significant as regards dental care global budget. When female subjects or highly educated people increased by 1%, the annual expenditure per person would increase by 36.04 NT dollars (i.e. 3.3%) and by 19.63 NT dollars (i.e. 1.8%), respectively. However, the agricultural population and socioeconomic factor had a negative association with dental utilization. When the agricultural population increased by 1% or average annual household income increased by 10 000 NT dollars, the annual expenditure per person decreased by 2.19 NT dollars (i.e. 0.2%) and by 3.25 NT dollars (i.e. 0.3%), respectively.

With respect to the factors affecting the frequencies of dental visits and frequencies of tooth-filling (Table 2), average household income became statistically insignificant ($P > 0.05$). After other variables were controlled, the market competition had similar effects on both annual frequencies of dental visits and frequencies of tooth-filling per person. With 1% increase in market competition, annual frequencies of dental visits and frequencies of tooth-filling per person increased by 0.004 times (i.e. 0.4%) and 0.0018 times (i.e. 0.4%), respectively. The female population, highly educated population, and agricultural population had similar effects on both annual frequencies of dental visits and frequencies of tooth-filling. For instance, when female subjects and highly educated people increased by 1%, the frequencies of dental visits per person increased by 0.025 (i.e. 2.5%) and 0.009 (i.e. 0.9%), respectively. However, when the agricultural population increased by 1%, the frequencies of dental visits per person decreased by 0.004 times (i.e. 0.4%). In all three regression models, the influence of changes in the age groups on dental utilization was not statistically significant ($P > 0.05$) after controlling for other relative factors.

Table 2. Results of multiple regression analysis for dental care, 1999–2002

Variables	Expenditure of dental care	Frequency of dental care	Frequency of tooth-filling
Intercept	−631.68 (560.71)	−0.59 (0.43)	−0.43 (0.24)
Market competition	−397.48 (114.10)**	−0.38 (0.09)**	−0.18 (0.05)**
Proportion of females	3604.30 (834.59)**	2.51 (0.64)**	1.41 (0.35)**
Proportion of age 0–4 years	811.39 (2721.47)	−1.11 (2.08)	0.20 (1.15)
Proportion of age 5–9 years	−4436.46 (4202.15)	−1.76 (3.20)	−1.78 (1.78)
Proportion of age 10–14 years	5687.08 (4047.16)	3.42 (3.09)	1.90 (1.71)
Proportion of age 15–24 years	−390.28 (1522.72)	0.98 (1.16)	0.62 (0.64)
Proportion of age 65 years and above	−462.51 (1012.65)	1.52 (0.77)	0.43 (0.43)
Average household income[a]	−324.5 (114.5)**	−0.06 (0.09)	−0.03 (0.05)
Proportion of highly educated population	1963.08 (444.59)**	0.85 (0.34)*	0.45 (0.19)*
Proportion of agricultural population	−219.13 (96.71)*	−0.39 (0.07)**	−0.20 (0.04)**
Adjusted R^2	0.58	0.62	0.59

[a]Unit: in million NT dollars.
*$P < 0.05$; **$P < 0.01$.
Values in parentheses are standard errors.

Discussion

Studies (15–19) have confirmed that asymmetric information between the providers of health care and patients causes supplier-induced demand because of marketing competition. According to the results of this study, under the dental global budget, market competition was significantly associated with the insured patients' dental utilization. The higher the market competition, the higher was the dental utilization. Based on further regression analyses, increases in the market competition could explain about 33% of the dental care expenditure. When market competition increases, it is expected that the average income of dentists will decrease; therefore, each patient's dental utilization would increase. This implies that supplier-induced demand significantly exists in the competitive dental care market.

Although trend analysis was not statistically significant for average market competition in HCSRs during this study period, the regression model analysis was to examine the relationship between market competition and dental utilization for each HCSR, for which a statistically significant relation was achieved. According to the regression models, a 1% increase in market competition would lead to about 0.4% growth regardless of dental expenditure, frequency of dental visits, or frequency of tooth-filling. In Taiwan, the number of dentists went up to 11.7% from the years 1999 to 2002 (1), and in the meanwhile the market competition, on average, increased 7.5% (see Table 1). Therefore, this 7.5% increase in market competition might account for the approximately 3% increase in dental expenditure and utilization during these 4 years.

The descriptive statistics showed age groups had high variation in dental utilization, but after we controlled for market competition, gender, household income, highly educated population, and agricultural population, the age groups became an insignificant factor for dental care utilization. On the contrary, three regression models indicated that a 1% increase in female population would be associated with a 2.5–3.3% increase in dental utilization, which reflected that the female population was one of the important factors affecting dental care utilization, a result consistent with previous studies (20, 21).

Our findings revealed that, after other variables were controlled, the increase in average household income was accompanied by a decrease in average dental utilization. However, people in lower income areas had higher dental care utilization, which might be because of their poor oral health. As nearly all citizens in Taiwan were covered by NHI dental insurance, the income effect on dental utilization was not significant. High-income families might spend much money on the dental care, not related to health problems, which is not covered by insurance such as orthodontics. These kind of out-of-pocket services were not included in the analysis. This situation might result in an underestimation of dental utilization for the high-income population.

From the results of regression analysis, the highly educated population was associated with higher dental utilization after controlling for other factors. The reason may be that highly educated people had a better perception of oral health and tend to have regular dental examinations. Our findings confirmed those reported in previous studies (5, 22). However, the dental utilization was lower in the areas with a higher proportion of agricultural population. After we further analyzed the relationship between market competition and the agricultural population, and between the highly educated population and the agricultural population in an HCSR, we found that areas with a large agricultural population had a lower market competition for dental care and fewer highly educated people. Therefore, these areas with more agricultural people had fewer dentists and lower accessibility, which would cause lower market competition and hence lower dental utilization.

Under the dental global budget payment in Taiwan, the growth of dental expenditures has been effectively controlled. When the national health insurance places a cap (i.e. a capped global budget) on dental care expenditures, the dentists may need to increase the services not covered by insurance to increase their income because of higher market competition.

Acknowledgments

We appreciate Taiwan's National Science Council for providing financial support for this study (grant NSC92-2320-B-468-002). We are also grateful to the National Health Research Institute for providing Taiwan NHI medical claim data for our analyses.

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