The Impact of Physician Supply on the Utilization of Ambulatory Care Under the National Health Insurance

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Objectives. Taiwan's annual national ambulatory care expenditure increased dramatically after the implementation of the National Health Insurance program (NHI). This research aimed to examine how the supply of physicians affect the use of ambulatory services in Taiwan.

Methods. The study used the sub-regions in the health care network as the unit of observation from 1996 to 1999. Information about ambulatory care utilization was collected from the NHI medical claim database. Other related information was obtained from the Taiwan Demographic Fact Book published by the Ministry of the Interior. We applied multiple regression analysis with the fixed-effects model for the statistical analysis. The model examined how the supply of physicians influenced ambulatory service utilization after controlling for extraneous factors.

Results. The research clearly demonstrated that the supply of physicians increased demand in ambulatory care after controlling for other factors. The results showed that an increase of one physician per 10,000 people increased the number of physician visits per capita by 2.43%, and the ambulatory care expenditure by 5.34%. The increase in the physician-population ratio accounted for 21.71% of the rise in ambulatory service expenditures from 1996 to 1999. The number of Chinese medicine physicians and the number of hospital beds did not significantly influence utilization of ambulatory medical care.

Conclusions. After Taiwan implemented the National Health Insurance program, the increase in the number of physicians increased the utilization of ambulatory care at the sub-region in the health care network. **(Mid Taiwan J Med 2004;9:27-37)**

Key words

ambulatory care, health care expenditure, physician supply

INTRODUCTION

Taiwan's health care expenditures have been rising since the National Health Insurance (NHI) was implemented in 1995. The proportion of health care expenditures to GDP gradually increased from 4.31% in 1993 to 5.44% in 1999 [1]. In particular, from 1996 to 1999, the ambulatory care expenditures escalated 31.49% [2]. The number of physician visits for ambulatory care rose to approximately 15 times per capita per year in 2000, which included Western medical care, traditional Chinese medical care, and dental care services [2]. It is important to probe into the cause of this issue.

Taiwan's National Health Insurance is a mandated, universal, and comprehensive health insurance program. Physicians receive a fee-for-service payment for ambulatory care visits. The Taiwan health care delivery system does not have a mandated referral system. Patients can choose primary care physicians in any hospital or clinic,

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and there is either no co-payment, or a very low co-payment. Thus, Taiwan's NHI completely reduces financial barriers to medical care, and largely increases the accessibility of health care. Following the implementation of the NHI system, patients tended to increase their utilization of health care resources. This is the so-called "moral hazard" phenomenon.

From 1996 to 1999, the number of physicians in Taiwan increased from 24,790 to 28,216, a 13.82% increase. The average physician-population ratio increased from 1:868 to 1:783 [1]. By comparison, the physician to population ratio in the United States could explain the 22% growth of total expenditures for physician services [3]. The rise in the number of practicing physicians theoretically could predict 96% variability in the rise of physician service-related expenditures, and a rise in total health care expenditures. This is based on data from the United States covering the 30-year period from 1970 to 1999 [4].

One of the characteristics of health care services is "asymmetry of information", which might cause the phenomenon of "supplier-induced demand". The increased ratio of physicians to population results in more intensive competition for shares of the health care market. The supplier-induced demand may be more severe under these circumstances. Previous studies, with various results, looked at supplier-induced demand based on different methods, periods, and areas. Some research showed that physicians were able to induce demand [5-8]. For example, there was a significant positive relationship between physician supply and hospital admissions, cost per hospital day, lengths of stays, physician fees for specialty services, and physician expenditures per capita in the United States [8]. In our earlier work, we found that the supply of Chinese medicine physicians had a positive relationship with ambulatory care expenditures on Chinese medicine in Taiwan [7]. However, other studies did not support the theory of supplier-induced demand [9-11].

According to the literature, the factors that influence health care expenditures are income, ratio of sex, age distribution of population, health insurance coverage, health insurance payment method, health care resources, medical technology, prices, and the population's general health [12-15]. In general, people with higher incomes spend more on health care, and consume more resources, as do women, as compared to men, and the very old, and very young [13-15].

Disease patterns have also changed over time due to the increase in life expectancy and changes in lifestyle. There are now more patients with cancer, cardiovascular diseases, and other chronic illness, which will require greater expenditures. Improvements in medical technology will also increase total health care expenditures. Medical technology will mostly influence inpatient care, but its impact on ambulatory care will be limited.

Changes in the price index for medical care consumption may also affect health care expenditures. Currently, the consumer price index and health care expenditures are moving in the same direction. However, how prices affect ambulatory care expenditures will be based on how physicians receive payment. If physician fees are fixed, changes in medical prices will not have any impact on patients' ambulatory care.

We were interested in the relationship between physician supply and ambulatory care utilization under Taiwan's National Health Insurance. We examined the impact of the availability of physicians, Chinese medicine physicians, and hospital beds on ambulatory care utilization, after controlling for other factors that might affect health care costs in a given area.

MATERIALS AND METHODS

This study analyzed only Western medical care, and excluded Chinese medicine and dental care, because approximately 84% of ambulatory physician visits were for Western medicine, and only 9% of all NHI medical claims, based on the Annual Statistical Report by the NHI, were for Chinese medicine. Statistical analysis was done by multiple regression analysis. After controlling

Table 1. Descriptive Analysis for Sub-Regions in Health Care Network (1996 to1999)

Variables	n	Mean	Min	Max
Average ambulatory care visits per capita per year	252	11.34	3.57	23.13
Average ambulatory care costs per capita per year (NT$)	252	6376.61	1232.37	20814.85
Physicians/10,000 people	252	12.12	2.11	30.90
Chinese medical physicians/10,000 people	252	1.46	0.00	4.46
Hospital beds/1000 people	252	5.55	0.00	73.13
Average annual family income (NT$ 10,000)	252	102.77	63.41	129.81
Female ratio (%)	252	49.68	33.23	50.26
Young age (≤ 14) ratio (%)	252	22.28	17.09	27.58
Aged (≥ 65) ratio (%)	252	8.14	4.84	14.11
Ambulatory care visits per capita in 1996	63	10.25	3.57	18.73
Ambulatory care visits per capita in 1997	63	11.04	3.70	20.20
Ambulatory care visits per capita in 1998	63	11.74	3.86	22.00
Ambulatory care visits per capita in 1999	63	12.32	4.29	23.13
Ambulatory care costs per capita in 1996 (NT$)	63	5582.82	1232.37	17185.77
Ambulatory care costs per capita in 1997 (NT$)	63	6019.89	1254.14	17886.22
Ambulatory care costs per capita in 1998 (NT$)	63	6650.56	1484.95	18847.54
Ambulatory care costs per capita in 1999 (NT$)	63	7229.21	1586.22	20814.85

for the enabling factors and predisposing factors, we analyzed the effects of changing physician supply and hospital beds on the utilization of ambulatory care. The dependent variables were the number of physician visits per capita, and cost of ambulatory care services per capita per year.

According to a previous study [7], physicians have a somewhat negative effect on the utilization of Chinese medicine when both are present in the same market. This means that patients might decrease visits to, or completely replace, Chinese medicine with Western medical care. Thus, we included the number of Chinese medicine physicians in the model to examine the substitution effect.

In the regression model, the independent variables were the number of physicians per 10,000 people, Chinese medicine physicians per 10,000 people, and the number of hospital beds per 1000 people, which represent the health care resources in a given area. The control variables were patient demographics: annual family income, ratio of men to women, and different age groups, including those younger than 15 and older than 64 years. Since physician fees for ambulatory care were not adjusted from 1996 to 1999 in Taiwan's NHI, the medical price index was excluded in the regression model.

Sixty-three sub-regions in the health care network were used as observation units. A sub-region in the health care network is a living area, mapped out by the Department of Health, where the health care needs of residents can be conveniently met. The study period was from 1996 to 1999. There were 252 observation units in the total sample. Information about ambulatory service utilization was collected from the NHI medical claim dataset. The data related to other variables were obtained from the Taiwan Demographic Fact Book published by the Ministry of the Interior.

We pooled time-series and cross-sectional data and applied fixed-effect models to perform the analysis. The fixed-effects model can analyze some omitted factors such as the population's health status, which may influence the health care expenditures, but are not easily measured. Because health service costs are highly skewed to the right, natural logarithm transformation of ambulatory care utilization can stabilize the heteroskedasticity with skewed data. In addition, each sub-region has different populations, so we used the size of the population as a weighted variable. The model can be expressed as follows:

$$Ln(Y_{i,t}) = \beta_0 + \beta_1 X_{i,t} + \beta_2 W_{i,t} + ... + \sum_{j=1}^{62} \gamma_j A_j + \varepsilon_{i,t}$$

Where Ln represents the natural logarithm

Table 2. Regression analysis of fixed-effects model for ambulatory care visits (n = 252)

Variables	Parameter	Standard error
Intercept	1.889**	0.623
Health care resources		
Physicians/10,000 people	0.024**	0.005
Chinese medical physician/10,000 people	0.001	0.024
Hospital beds/1000 people	−0.000	0.002
Economic factor		
Average family income (in NT$100,000)	0.002*	0.001
Population structure		
Female ratio	−0.339	1.077
Young age ratio	−3.566**	0.642
Aged ratio	10.888**	1.406
Sub-regions		
Taipei	Reference	
Keelung	0.024	0.048
Pingwu	−0.499**	0.046
Sanying	0.519**	0.084
Tailin	−0.172**	0.047
Tanchih	−0.806**	0.101
Taoyuan	0.339**	0.031
Chungli	0.216**	0.043
Jushi	0.243**	0.037
Jubei	0.157**	0.054
Jutung	−0.315**	0.073
Miaoli	−0.584**	0.093
Chunggang	0.106	0.068
Haishian	0.183**	0.054
Shanshian	−0.916**	0.121
Taichung	0.440**	0.062
Tachia	0.468**	0.043
Chingshui	0.157**	0.059
Wufeng	0.598**	0.045
Fengyuan	0.531**	0.077
Nantou	0.470**	0.041
Tsautuen	−0.181**	0.070
Buli	−0.565**	0.095
Jushan	0.412**	0.064
Changhwa	−0.365**	0.092
Lukang	−0.054	0.069
Erlin	0.225**	0.061
Yuanlin	−0.061	0.073
Tianchung	−0.255**	0.084
Touliou	−0.163	0.090
Huuei	−0.332**	0.102
Beigang	0.189**	0.076
Taishi	0.303**	0.069
Shiluo	−0.482**	0.108
Chiayi	0.562**	0.044
Chiadung	−0.708**	0.092
Chiabei	−0.245**	0.097
Chiashi	−0.609**	0.104
Tainan	−0.059	0.086

$R^2 = 0.985$, adjusted $R^2 = 0.980$. *$p < 0.05$, **$p < 0.01$.

Table 2. Continued

Variables	Parameter	Standard error
Shining	−0.227**	0.090
Shinhua	−0.075	0.070
Tzenguen	−0.104	0.070
Beimen	0.415**	0.040
Shinfeng	−0.157	0.093
Kaoshiung	0.222**	0.055
Gangshan	0.079	0.063
Chishan	0.391**	0.040
Hsiaokang	−0.517**	0.091
Pingtung	0.180**	0.047
Tunggang	−0.077	0.074
Chaujan	0.077	0.085
Kaoshu	−0.651**	0.101
Hengchuen	−0.540**	0.108
Taitung	0.020	0.077
Chenggung	−0.752**	0.133
Guanshan	−1.155**	0.130
Tawu	−0.984**	0.118
Hualian	0.013	0.053
Fenglin	−0.656**	0.109
Iuli	−0.735**	0.158
Ilan	−0.008	0.064
Luotung	0.142**	0.051
Penghu	−0.268*	0.110

transformation; Y is the frequency or expenditures of ambulatory care per capita per year in one sub-region; X, W, Z are the independent variables including the number of physicians per 10,000 people, Chinese medicine physicians per 10,000 people, the number of hospital beds per 1000 people, annual family income, ratio of men to women, and different age groups; Aj is the set of 62 dummy variables for 63 sub-regions in the health care network; β and γ indicates regression coefficients; the suffix i indicates the observation area; the t indicates the year from 1996 to 1999; and ε is the error term.

This study also examined serial correlation by Durbin-Watson statistics for the regression models. In general, a DW value close to 2 indicates low serial correlation. In this study, the cost model's DW value was 1.90, and the frequency model's DW value was 1.50 which may have had a positive serial correlation. Serial correlation will not affect the unbiasedness or consistency of the regression estimators, but it affects their efficiency, which means that the standard errors of regression estimators may be biased [16].

Some researches prefer to use a first-differencing model to reduce the influence of serial correlation in time serial data. However, the first-differencing model has a disadvantage, because it does not include or control for the omitted factors which will cause the bias of regression estimators. After comparing the trade-off between the fixed-effects model and the first-differencing model, we preferred to apply the fixed-effects model in this study because it provides more precious regression estimators although it might influence the regression estimators' efficiency.

RESULTS

Table 1 presents the descriptive analysis of average utilization of ambulatory care, medical care resources, and control variables for 63 sub-regions in the health care network from 1996 to

Table 3. Regression analysis of fixed-effects model for ambulatory care cost (n = 252)

Variables	Parameter	Standard error
Intercept	8.760**	0.997
Health care resources		
Physicians/10,000 people	0.052**	0.008
Chinese medical physicians/10,000 people	−0.063	0.038
Hospital beds/1000 people	0.003	0.003
Economic factor		
Average family income (in NT$100,000)	0.002	0.001
Population structure		
Female ratio	−0.3405	1.0871
Young age ratio	−3.8791**	0.6251
Aged ratio	10.8803**	1.4206
Sub-regions		
Taipei	Reference	
Keelung	−0.155*	0.077
Pingwu	−1.131**	0.074
Sanying	0.668**	0.135
Tailin	−0.264**	0.075
Tanchih	−1.210**	0.161
Taoyuan	0.362**	0.049
Chungli	0.180**	0.069
Jushi	0.204**	0.060
Jubei	0.100	0.087
Jutung	−0.605**	0.116
Miaoli	−0.943**	0.149
Chunggang	−0.032	0.108
Haishian	0.193*	0.086
Shanshian	−1.513**	0.193
Taichung	0.374**	0.100
Tachia	0.617**	0.069
Chingshui	−0.154	0.095
Wufeng	0.588**	0.072
Fengyuan	0.663**	0.123
Nantou	0.638**	0.065
Tsautuen	−0.385**	0.112
Buli	−0.643**	0.152
Jushan	0.262**	0.103
Changhwa	−0.522**	0.147
Lukang	−0.098	0.111
Erlin	0.089	0.098
Yuanlin	−0.096	0.117
Tianchung	−0.374**	0.135
Touliou	−0.739**	0.144
Huuei	−0.661**	0.164
Beigang	−0.087	0.121
Taishi	0.074	0.111
Shiluo	−1.036**	0.172
Chiayi	0.438**	0.070
Chiadung	−1.176**	0.148
Chiabei	−0.768**	0.155
Chiashi	−0.799**	0.167
Tainan	−0.535**	0.138

$R^2 = 0.986$, adjusted $R^2 = 0.981$. $^*p < 0.05$, $^{**}p < 0.01$.

Table 3. Continued

Variables	Parameter	Standard error
Shining	−0.587**	0.145
Shinhua	−0.341**	0.112
Tzenguen	−0.289**	0.112
Beimen	0.387**	0.064
Shinfeng	−0.601**	0.148
Kaoshiung	−0.116	0.087
Gangshan	−0.279**	0.101
Chishan	0.273**	0.065
Hsiaokang	−0.845**	0.146
Pingtung	0.067	0.075
Tunggang	−0.524**	0.118
Chaujan	−0.197	0.136
Kaoshu	−1.036**	0.162
Hengchuen	−1.151**	0.173
Taitung	−0.048	0.123
Chenggung	−1.258**	0.212
Guanshan	−1.702**	0.208
Tawu	−1.405**	0.189
Hualian	−0.079	0.085
Fenglin	−1.178**	0.174
Iuli	−1.233**	0.253
Ilan	−0.242*	0.103
Luotung	0.051	0.082
Penghu	−0.626**	0.176

1999. The average number of ambulatory visits was 11.34 per capita per year. Because of the variation in availability of health care resources, the highest number of physician visits was 23.13, and the lowest was 3.57 per capita per year. The average ambulatory care cost was 6377 NT dollars per capita per year, and the highest was 20,815 NT dollars per capita per year, which is about 17 times higher than the lowest.

The average physician density was 12.12 per 10,000, and the highest was 30.90, about 15 times higher than the lowest. The average density of Chinese medicine physicians was 1.46 per 10,000, which was lower than the density of physicians of Western medicine. The highest was 4.46 and the lowest was zero. The average ratios for young children (less than 15 years), women, and the elderly (more than 64 years) were 22.3%, 48.7%, and 8.15%. The average annual family income was 1.03 million NT dollars.

Table 2 displays regression results of the frequency model of physician visits for ambulatory care. The regression coefficient of physician density was 0.024, which was statistically significant ($p < 0.05$) after controlling for the other variables. The density of Chinese medicine physicians did not significantly influence utilization of ambulatory medical care. Changes in hospital beds also did not significantly influence physician visits for ambulatory care.

Demographic changes, such as changes in the ratios of young children and the elderly did significantly influence the number of physician visits. Being a controlled variable, annual family income represents an economic factor, and was statistically significant for the number of physician visits (Table 2). This means that the number of physician visits for ambulatory care was influenced by family income under the NHI. Table 3 shows regression results for the cost model, which had similar results to that of the frequency model, but community-level family income did not significantly influence ambulatory care expenditures.

DISCUSSION

According to the results, ambulatory care expenditures had a positive relationship with physician density. This means that increase in the physician-population ratio corresponded to an increase in the utilization of ambulatory care. Based on the regression models, after controlling for other factors, the relationship between physician density and ambulatory care utilization can be expressed as follows:

$$Y_{t2} \div Y_{t1} = e^{\beta*(MDt2 - MDt1)}$$

Where Y is the physician visits per capita per year or ambulatory care expenditure per capita per year in a sub-region; MD is the number of physicians per 10,000; t indicates the years; β is the regression coefficient of MD.

Based on equation 2, as other factors were fixed, increasing one physician per every 10,000 people would increase the number physician visits per capita per year by 2.43%, and increase the ambulatory care expenditures per capita per year by 5.34%. Since Taiwan's supply of physicians increased by 1.24 physicians per 10,000 people from 1996 to 1999, it caused an increase of 3.01% in the number of physician visits and a 6.66% in ambulatory care expenditures per capita per year, according the regression models. This implies that the total ambulatory care expenditure increased 6.66% due to the growth in density of physicians from 1996 to 1999 in Taiwan. There was a corresponding population-growth of 2.63% and a total increase in expenditures on ambulatory care of 31.49%. After controlling for the influence of population growth on health care expenditures, the actual growth rate of ambulatory care expenditures was 30.68%. After the calculation based on the model, the increase in the physician-population ratio accounted for 21.71% of the increase in total ambulatory care expenditures during these four years.

During the study period, the number of Chinese medicine physicians increased only 0.233 per 10,000 people. The ratio of Chinese medicine physicians to Western medicine physicians was about 1:8 in 1999 in Taiwan [1]. The annual ambulatory care expenditure ratio of Chinese medicine to Western medicine was 1:17 in 1999 [1]. This suggests that most patients preferred Western medicine physicians for ambulatory care. This study attempted to discern if the availability of Chinese medicine would influence patients' utilization of Western medicine. According to the regression model, the increase in the number of Chinese medicine physicians did not significantly decrease utilization of Western medicine. Our previous study found that the availability of Western medicine reduced the utilization of Chinese medicine when both were available in the same health care market [7]. This means that Western medicine physicians competed with Chinese medicine physicians for ambulatory care patients, and that Western medicine ambulatory care, to some extent, significantly substituted for Chinese medicine when both are available in the same market. However, the reverse is not true.

Taiwan's payment system for ambulatory care is a fee-for-service system. The fact that increases in the number of physicians caused the utilization of ambulatory care to increase could be explained in two ways. First, increased physician density led to an increase in physician competition for market share. This increased the phenomenon of supplier-induced demand. The second possible explanation was that higher physician density might increase patients' access to ambulatory care, particularly in areas with previously insufficient medical services.

However, the actual reason depends on the "carrying capacity" for physicians in one area [17,18]. If the physician supply is within the carrying capacity for physicians in one area, the real impact of physician growth may have more to do with increased patient accessibility than supplier-induced demand. However, if physician growth outpaces carrying capacity for physicians in one area, the effect of supplier-induced demand may be higher than that of increasing accessibility.

Physician density varies greatly across sub-regions in the health care service network. If we

included Western medicine physicians and Chinese medicine physicians in one sub-region in 1999, the highest and lowest physician densities were 35.31 and 3.16, respectively, per 10,000 people. This suggests that in some sub-regions physician density increased so much that there was supplier-induced demand for ambulatory care services. However, physician density was so low in some sub-regions that physician growth increased accessibility, a market situation that might not increase supplier-induced demand. Both effects might exist when the physician density rises, but we could not distinguish the magnitude of the effects based on our models, and further analysis is required.

The increase in the number of hospital beds did not significantly increase the utilization of ambulatory care in Taiwan. This might be because after Taiwan implemented the National Health Insurance in 1995, the ratio of ambulatory care expenditures to inpatient care expenditures was approximately 65:35. This situation is very different from other countries. In general, developed countries have more inpatient care expenditures than ambulatory care expenditures. In Taiwan, average annual physician visits per capita were 15 for medical care services from 2001-2002. This means that Taiwan patients used so many ambulatory care services that increases in hospital beds would not significantly increase total utilization in ambulatory care. Average annual family income did not significantly increase average ambulatory care expenditures, but did significantly influence the number of physician visits for ambulatory care in the regression models. Taiwan's NHI is a universal and comprehensive health insurance plan, and patients only need to pay a few out-of-pocket fees to use ambulatory care services, but higher-level income communities still had slightly higher ambulatory care visits. Previous studies have shown that price elasticity for ambulatory care services was very small, and when patients had health insurance, the price elasticity of ambulatory care became much smaller [19-20]. This reflects the finding that patient demand for ambulatory care was not largely influenced by the cost of ambulatory care under Taiwan NHI.

Changes in age distribution of the population significantly influenced ambulatory care utilizations after controlling for the health care resources. Changes in the percentage of children under 15 years and adults over 64 years affected the ambulatory care cost per capita. But increases in the ratio of children under 15 years decreased ambulatory care utilization. The study results are similar to our previous study results [7]. The reason might be that this study examined only ambulatory care rather than total medical care costs, and the result is the net effect of pooling all areas with different health care resources, such as physicians and hospital beds in the model. Further study is needed to find the actual reason.

We controlled for hidden factors such as population health status by the fixed-effects model. Besides factors such as health care resources, income, and the population's demographic structure, different sub-regions in the health care network had different per capita utilization of ambulatory care. Hidden factors, such as lifestyle, health behaviors, and general health status would cause different ambulatory care demands across the sub-regions in the health care network.

In short, Taiwan might not run short of physicians, but physician distribution is unbalanced across sub-regions in the health care network. Physicians prefer to practice in cities, which causes a shortage of physicians in rural areas. Under the fee-for-service payment system, physicians could have supplier-induced demand to earn target income, especially when physicians think physician fees of ambulatory care are too low. If Taiwan would like to increase the number of physicians and contain the escalation of ambulatory care costs, health care payment policy needs to provide incentives to encourage physicians to practice in rural areas and increase access to health care.

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